



CONSTRUCTION STANDARDS AND SPECIFICATIONS

Public Works Department

Westfield, Indiana

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SECTION 00200 – FOREWORD

The enclosed Construction Standards Details and Specifications are provided to outline the City of Westfield's (City) minimum criteria for construction of infrastructure and appurtenances within the jurisdiction of the City of Westfield.

All construction projects that are to become part of the City's system for operation and maintained by the City shall conform to the latest standards and details. Construction drawings and specifications must be stamped and signed by a registered professional engineer, licensed in the State of Indiana, shall be approved by the Westfield Public Works Department (WPWD), and be in accordance with these standards and specifications before construction begins. All construction plans must include a copy of these standards and specifications. A PDF version of this document can be obtained via the information below.

All construction plans and specifications shall be submitted to the WPWD for review and will be stamped by the WPWD once the plans and specifications are found to be in compliance with all City standards and specifications. One hard copy and a digital copy of the construction plans shall be submitted to the WPWD.

Any permits that need to be obtained outside of the control of the City shall so be done through the applicable utility or jurisdiction having authority. Any storm water storage or conveyance system must be submitted to the WPWD. For any storm water storage or conveyance system discharging to a drain regulated by the Hamilton County Surveyor must have plans submitted to that entity for approval as well as the WPWD.

Before any off-site (property not owned by the developer) utility construction can commence, all permanent and/or temporary easements shall be executed and conveyed to the City.

A preconstruction conference is required and a minimum of 48 hours notice shall be given prior to starting construction. **If right-of-way utility relocations are required, work plans must be submitted along with schedules for this work before the preconstruction conference will be scheduled.** Performance bonds, if obtained, and submittals for all infrastructure to be constructed shall be submitted to the WPWD and approved by the City before a preconstruction conference date can be set. A preconstruction conference can be scheduled by contacting the WPWD.

Construction observation shall be provided by the WPWD. Each and every time infrastructure construction is to commence, WPWD inspectors are to be notified 48 hours in advance. Inspection hours shall be invoiced on a monthly basis per [Ordinance 13-32](#). Any inspection performed outside of normal business hours, Monday through Friday 7:30am – 4:30pm, shall be billed out at a rate of 1.5x standard rates. It is the responsibility of the developer to ensure these invoices are paid.

WPWD reserves the right to stop all site work which is determined insufficient or not in accordance with the Standards and Specifications defined herein.

These standards were prepared with the intent of obtaining the highest quality of construction possible. As new materials become available and acceptable, the standards may be revised and updated.

Copies of the standards may be obtained from the City of Westfield website via <http://www.westfield.in.gov/> or the Westfield Public Works Department (contact information below):

Westfield Public Works Department
City Services Building
2706 East 171st Street
Westfield, Indiana 46074
Phone: 317-804-3100

SECTION 00300 - GENERAL REQUIREMENTS

1.1 DEFINITIONS

- A. Whenever used in these specifications the following terms have the meanings indicated which are applicable to both the singular and plural thereof:
1. City - The City of Westfield, represented by the City Council.
 2. Board of Public Works and Safety – Representatives appointed by the Mayor of Westfield that oversees the affairs of the Westfield Public Works Department and Public Safety Agencies.
 3. Westfield Public Works Department (WPWD) – An agency of the City which manages public infrastructure within its jurisdiction.
 4. Utility – The entity, municipal or otherwise, that provides services to the general public and has jurisdiction for expansion of services within the limits of the service area.
 5. Developer - Person or firm having control of the development site, and management of the project.
 6. Contractor - The person, firm or corporation with whom the Developer or City has entered into an agreement for construction of the project.
 7. Project - The total construction of which the work to be provided may be the whole or part.
 8. Work - The entire completed construction or the various separately identified parts thereof required to be furnished.
 9. The word “shall” is mandatory; the word “may” is permissive.

1.2 WORK TO BE PERFORMED

Work to be performed shall be in accordance with drawings and specifications included in this manual and/or approved by the City.

1.3 SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

The Contractor shall be solely responsible for all obligations prescribed as employer obligations under Chapter XVII of Title 29, Code of Federal Regulations, Part 1926, otherwise known as "Safety and Health Regulations for Construction." All contractors performing work within the City's jurisdiction must meet with WPWD's Inspector as part of the required preconstruction conference prior to beginning work.

1.4 DISCOVERY OF HAZARDOUS MATERIAL

If, during the course of installing City infrastructure, the existence of hazardous material, including asbestos containing material, is observed in the work area, the Contractor shall immediately notify the Developer and the City in writing. For City and Developer projects, the Contractor shall not perform any work pertinent to the hazardous material prior to receipt of special instructions from the City of Westfield. Asbestos containing material includes transite pipe.

1.5 EASEMENTS

- A. For City projects, the City will obtain utility and/or drainage easements over and through certain private lands for construction.
- B. For Developer projects, the Developer will obtain utility and/or drainage easements over and through certain private lands for construction. The width or limits of such easements will be defined by the City, and all permanent and/or temporary easements shall be executed and conveyed to the City before any construction can commence. If the methods of construction employed by the Contractor are such as to require the use of land beyond the limits obtained, he shall make his own agreements with the property owners affected for the use of such additional land.
- C. If the methods of the construction employed by the Contractor are such as to require the use of land beyond the defined easement(s), he shall make his own agreement(s) with the property owners affected for the use of such additional land and shall provide a copy of the agreement(s) to the WPWD.
- D. In all such utility and/or drainage easements, the Contractor shall be required to carefully remove the property owner's fence, or other obstacles to the construction procedure, and it shall be the property owner's responsibility to reinstall their fence. The backfilling shall be to the grade of the existing ground level or to the grade as established by the property owner in the event the property owner permits the deposit of excess material upon such land.
- E. Any obstruction in the easement shall be removed by the homeowner before construction begins. If said obstruction is not removed prior to construction activities, the City/contractor will remove the obstruction and will not be responsible for damage and reinstallation to said obstruction.
- F. The cost of all such restoration of property with exception of the items listed above in section E shall be done by the Contractor.

1.6 OPERATIONS WITHIN RIGHT-OF-WAY

In public thoroughfares, all operations of the Contractor, including those of temporary nature, must be confined within the applicable right-of-way limits after having obtained approval of the City or other Local Governing Entity. If the methods of the construction employed by the Contractor are such as to require the use of land beyond the public thoroughfares, he shall make his own agreement(s) with the property owners affected for the use of such additional land and shall provide a copy of the agreement(s) to the WPWD.

1.7 PERMITS AND BONDS

A. PERMITS

The Developer will obtain and provide electronic copies of the approved permit(s) which relate to the completed facilities prior to construction. For City projects, the permits will be either obtained by the City or defined in the contract. Permits obtained by the Developer and/or the City include, but not limited to, permits from the following:

1. City of Westfield
2. Department of Natural Resources
3. Indiana Department of Environmental Management
4. U.S. Army Corps of Engineers
5. Indiana Department of Homeland Security Building & Fire Safety
6. Indiana Department of Transportation
7. Railroads
8. Hamilton County Surveyor's Office
9. Hamilton County Highway Department
10. Soil and Water Conservation District
11. Public and private utility approval(s) or permit(s)

It is the Developer's responsibility to ascertain what permits are required, including wetland delineation and mitigation.

B. BONDING

The Contractor may obtain the necessary bond(s) per [Indiana House Bill 1508](#), effective July 1, 2015 or letter of credit(s) for City projects and Developer shall obtain permits for Developer projects or otherwise approved by the Board of Public Works and Safety which relate to construction procedures as prescribed in the most current City of Westfield Unified Development Ordinance.

1. All necessary permits and/or bonds required in conjunction with construction activities within or under easements and/or public right of ways shall be required to be obtained prior to construction. The construction shall be performed by the Contractor in full accordance with any and all requirements of the State Highway

Commission, County Road Commission, WPWD, or other Local Governing Entity including those applying to barricades, watchmen, guarding, lighting, storage of supplies, equipment and excavated materials, method of backfilling, final grading, replacement of pavement or road surface, and all other conditions or requirements which may be stipulated by the State Highway Commission, County Road Commission, or WPWD, whether specifically shown on the drawings or mentioned in the specification.

2. For Developer projects, which include City infrastructure, the Developer per [Indiana House Bill 1508](#):
 - a. Shall provide a performance bond and/or letter of credit for 110% of the engineer's estimate or the contracted amount to perform the work for any improvements within Public Right-of-Way in addition to any erosion control improvements. This performance bond or letter of credit shall have no expiration date and must be received by the City prior to the preconstruction meeting, or
 - b. Shall, to the satisfaction and approval of WPWD complete the following:
 - (1) Completion and acceptance of all drainage infrastructure including storm sewers, sub-surface drains, manholes, and any other infrastructure associated with drainage within the project limits. This includes but not limited to pipe being installed, backfill, and collars poured; manholes installed, flowlines poured, interiors grouted, and castings properly installed. As part of the acceptance, as-builts (both digital and hard copy) but be submitted for review. Televising and cleaning will be analyzed on a case-by-case basis and MAY NOT be required to be completed prior to secondary plat being signed. This determination will be made by the Director.
 - (2) Completion and acceptance of all finish grading and permanent erosion control measures through all rear-yard swales, detention areas, and in any areas associated with the overall drainage of the site.
 - (3) Completion and acceptance of all silt fence around rear-yard swales, detention areas, and back of curbs throughout the entire section of development. Please note that once work plans are received from dry utility representatives, an onsite pre-con

meeting for utilities shall be coordinated by the developer with all contractors associated with the utilities as well as the City of Westfield representative. During this meeting, accommodations for the dry utility contractors shall be made regarding the gapping of the silt fencing. Once dry utilities are completed, gaps in silt fencing shall be completed within 48-hours.

- (4) Completion and acceptance of all asphalt roadways (up to binder at a minimum minimum), concrete curb and gutters, temporary cul-de-sacs, passing blisters, acceleration and deceleration lanes, and any other offsite right-of-way improvements throughout the entire section of development. Temporary pavement striping may be necessary due to weather limitations on permanent pavement markings. Please note that it is the responsibility of the developer to coordinate all utility relocations in a timely manner to ensure these improvements can be completed. The City will work diligently with the Developer to ensure the relocation work plans are properly engineered to hastily accommodate any Encroachment Permit that may be required. It is NOT the responsibility of the City to coordinate these relocations in a timely manner – the City recommends coordinating as early as possible. Please note that the City will NOT accept paving around power poles as a solution to poor utility coordination. Also, performance bonds will be required for all surface and other incomplete infrastructure.
- (5) Completion and acceptance of all regulatory and street name signage for traffic control and E-911 services.
- (6) Written confirmation from CEG that water is active throughout the entire section of development for fire protection services.
- (7) Completion and acceptance of all common area sidewalks, and trails.
- (8) Punchlist items for the above-mentioned tasks shall be completed within 30 business days from the day the punchlist is formulated.

3. Payment in Lieu of Bond:

- a.) The WPWD has the discretion for an entity obligated to provide performance bonds to the City to allow a payment in cash to the City in lieu of a performance bond.
 - b.) The cash in lieu of bond shall be equal to 5% of the contractor estimate for the cost of the appropriate portion(s) of a development requiring a performance bond.
 - c.) Payment in Lieu of Bond may be accepted for partial completion, at the discretion of the WPWD. Remaining costs to complete this work shall be determined by a professional engineer and agreed upon by WPWD.
4. Performance bonds will not be considered for release until all punch list items are complete, easements and/or public right of ways are recorded or platted, and as-built drawings are submitted to WPWD. A digital copy shall be provided. Performance bonds shall only be released by the Board of Public Works once the above items have been completed.
5. After all City infrastructure has been inspected, tested, approved, and required as-builts have been submitted and approved by the City/WPWD, the performance bond and/or letter of credit can be flipped to a 3 year maintenance bond posted with the City. The maintenance bond shall be in the amount of 10% of the actual construction cost. Maintenance bonds shall be released by the Board of Public Works at the end of the 3 years once all maintenance punch list items are complete which includes, but not limited to the following:
- a.) To verify that all enclosed drains and sewers are functioning properly, all storm sewer including sub-surface drains are to be cleaned and televised with visual recordings (via closed circuit television) of such tile drains and sewers shall be required before release of maintenance sureties. These visual recordings will be scheduled at least 90 days prior to the expiration date of the maintenance bond. Reports summarizing the results of the noted visual recordings shall be reviewed and accepted by the WPWD and Utility or designee before maintenance sureties would be recommended to be released.

1.8 MAINTAINING TRAFFIC

- A. Developer is responsible for preparing maintenance of traffic plans for any construction activities that will interfere with public transportation. Traffic control devices used for maintenance of traffic shall comply with the latest version of the Indiana Manual on Uniform Traffic Control Devices. These maintenance of traffic plans must be included in the construction plans that are submitted to the City. The Contractor will provide maintenance of

traffic plans associated with City projects unless otherwise specified in the contract. If there are modifications to the maintenance of traffic plans, it must be reviewed by the City prior to implementation.

- B. Before closing any thoroughfare, the Contractor shall notify and, if necessary, obtain permit(s) from the duly constituted public authority having jurisdiction, which may include the state, county, and city/town. The contractor will be responsible for notifying the local school corporation, all public safety agencies, government agencies, and any affected property owners at least 72 hours in advance. The Contractor shall provide the WPWD a detour route plan for review prior to the road closure at least 1 week in advance.
- C. The Contractor shall place advanced road closure signs posting the closure date at a minimum 72 hours in advance to closure. The Contractor shall place all proper detour signs and barricades prior to the actual street closing.
- D. During construction, the Contractor shall be responsible for maintaining and protecting the pedestrian and vehicular traffic at all times on all streets involved and providing access to all residential and commercial establishments adjacent to the construction area. Emergency vehicle access must be maintained at all times. The Contractor shall furnish and maintain signage, barricades, flares, etc., in accordance with the latest version of the Indiana Manual on Uniform Traffic Control Devices. The signage, barricades, etc., must be in good condition and the City has the right to reject if determined to be in less than good condition.
- E. The Contractor shall conduct his work in such a manner as not to unduly or unnecessarily restrict or impede normal traffic through the streets of the community. Insofar as it is practicable, do not locate excavated material and spoil banks in such manner as to obstruct traffic or line of sight. Keep the traveled way of all street, roads, and alleys clear and unobstructed insofar as is possible. Do not use streets, roads, or alleys for the storage of construction materials, equipment supplies, or excavated earth, except when and where necessary as determined by WPWD. If required by duly constituted public authority, the Contractor shall, at his own expense, construct bridges or other temporary crossing structures over trenches so as not to unduly restrict traffic. Such structures shall be of adequate strength and proper construction and shall be maintained by the Contractor in such manner as not to constitute an undue traffic hazard. Private driveways shall not be closed, except when and where necessary as determined by WPWD, and then only upon due advance notice to the WPWD and Homeowner or Business owner, and for the shortest practicable period of time, consistent with efficient and expeditious

construction. The Contractor shall be liable for any damage to persons or property resulting from his work.

- F. Streets in which excavation has occurred shall be temporarily restored to receive traffic as soon as possible. Permission to close additional streets shall be denied if, in the opinion of the City, the restoration on streets where excavation has occurred has not progressed satisfactorily.

1.9 SIDEWALKS AND PASSAGEWAYS

The Contractor, when required, shall make provisions at cross streets for the free passage of vehicles and foot passengers, either by bridging or otherwise. Do not obstruct the sidewalks, curb and gutters, or streets, or prevent in any manner the flow of water in streets. Use all proper and necessary erosion and sediment control measures as required within this Standards Manual to permit the free passage of surface water along the curb and gutters. The Contractor shall immediately remove all material, exercising such precaution as may be directed by the City. All material excavated shall be so disposed of as to inconvenience the public and adjacent tenants as little as possible and to prevent injury to trees, sidewalks, fences, and adjacent property of all kinds. The Contractor may be required to erect suitable barriers to prevent such inconvenience or injury.

1.10 WARNING LIGHTS AND ARROW BOARDS

The Contractor shall place sufficient warning lights and arrow boards on or near the work and keep them illuminated during periods of construction and reduced visibility (from twilight in the evening until sunrise) and shall be held responsible for any damages that any party or the Developer may sustain in consequences of neglecting the necessary precaution in prosecuting this work.

1.11 UTILITIES

- A. Temporary Removal: All existing City utility systems which conflict with the construction of the work herein which can be temporarily removed and replaced shall be accomplished at the expense of the Developer with approval from the WPWD, unless the City specifies the use of its own contractor at the Developer's expense.
- B. Permanent Relocation of Utilities: All public and private utilities located in the public right-of-way which permanently interfere with the proposed improvements will be relocated and paid for by the Developer. The Developer must coordinate and gain approvals from each specified utility prior to relocating their facility.
- C. No infrastructure shall be installed outside of normal working hours Monday through Friday (7:30 am to 4:30 pm) without the presence of the

WPWD Inspector. WPWD shall be notified no later than Noon on Thursday prior to work being scheduled for the following Saturday. If this condition is not met, no work shall commence on Saturday.

1.12 SUBMITTALS - CERTIFICATE OF COMPLIANCE

The Developer shall upon request of the City, submit to the WPWD a Certificate of Compliance from the manufacturer and/or supplier of each and every specified material or manufactured equipment item. The Certificate shall state that the material or the item of equipment to be furnished has been manufactured with materials in accordance with the applicable sections of all required codes, specifications, and standards as required by the specifications.

1.13 MANUFACTURER'S SERVICE TIME

- A. When equipment is to be furnished by the Developer or Contractor and maintained in the future by the WPWD, service by the manufacturer is required to be provided as part of the work and the cost shall be covered by the Developer for Developer projects and by the Contractor for City owned projects. A minimum of one (1) year warranty is required unless an extended specified warranty is offered or standard warranty for that equipment is longer than the minimum of one (1) year.
- B. The service provided shall be by a qualified representative to check the completed installation, place the equipment in operation, and instruct the City's operators in the operation and maintenance procedures.
- C. The services shall further demonstrate to the City's complete satisfaction that the equipment will satisfactorily perform the functions for which it has been installed.

1.14 DIGITAL AS-BUILTS/RECORD DRAWINGS

The Developer will be responsible for preparation and submittal of digital as-builts/record drawings in state plane coordinates as required by the requirements set forth in the City's Digital As-built requirements. Copies of the most recent requirements are available on the City's website at www.westfield.in.gov and also at the following location: <http://www.hamiltoncounty.in.gov/668/HagTag>

Additional information can also be received from the WPWD or the Informatics Department.

Developers shall hire a licensed professional engineer or land surveyor to provide all required As-Built information.

END OF SECTION 00300

SECTION 02222 – STANDARDS FOR UTILITY CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Specifications for the stripping of topsoil and vegetation, excavation, trenching, bedding, filling, backfilling, compaction, pavement restoration, and related work in connection with the installation of water mains, gravity sanitary sewers, storm sewers, force mains, and other City owned utilities are included in this Section.
- B. Definitions
 - 1. Excavation: Removal of earth and rock to form a trench for the installation of a water main, gravity sanitary sewer, storm sewer, force mains, and other City owned utilities.
 - 2. Earth: Unconsolidated material in the crust of the Earth derived by weathering and erosion. Earth includes:
 - a. Materials of both inorganic and organic origin;
 - b. Boulders less than 1/3 cubic yard in volume, gravel, sand, silt, and clay;
 - c. Materials which can be excavated with a backhoe, trenching machine, drag line, clam shell, bulldozer, highlift, or similar excavating equipment without the use of explosives, rock rippers, rock hammers, or jack hammers.
 - 3. Rock: A natural aggregate of mineral particles connected by strong and permanent cohesive forces. Rock includes:
 - a. Limestone, sandstone, dolomite, granite, marble, and lava;
 - b. Boulders 1/3 cubic yard or more in volume;
 - c. Materials which cannot be excavated by equipment which is used to remove earth overburden without the use of explosives, rock rippers, rock hammers, or jack hammers;
 - d. Materials which cannot be excavated with a backhoe, trenching machine, drag line, clam shell, bulldozer, highlift, or similar excavating equipment without the use of explosives, rock rippers, rock hammers, or jack hammers.
 - 4. Undercutting: Excavation of rock and unsuitable earth below the bottom of the pipe or conduit to be installed in the trench.

5. Subgrade: Undisturbed bottom of a trench.
6. Bedding: Material placed in trench to support pipe and conduit as specified for the utility.
7. Backfill and Fill: Material placed in trench from the top of bedding to finished grade, or to subbase of pavement as specified for the utility.
8. Topsoil: Earth containing sufficient organic materials to support the growth of grass as specified by current USDA standards and specifications.
9. Dry utility: Any utility including electric, gas, telephone, cable, fiber, and other utilities not associated with water, sanitary, or storm sewers.

1.2 SEPARATION REQUIREMENTS

- A. All new dry utilities shall maintain a minimum separation of 3.0 feet from all storm structures and pipe.
- B. Minimum horizontal separation between storm sewers, water and sanitary sewers shall be 10.0 feet and 8.0 feet to the structures.
- C. Utility pedestals shall not be placed on top of storm sewer lines.

1.3 SITE CONDITIONS

- A. Existing storm sewers, sanitary sewers, water mains, gas mains, electric ducts, fiber optic ducts, telephone ducts, steam mains, wells, septic systems, wetlands, sink holes, geothermal, regulated drains, and other under-ground structures, lines, and their house connections are to be shown on the plans according to the best available information. The exact location and protection of these facilities and structures, their support and maintenance in operation during construction (in cooperation with the proper authorities), is the responsibility of the Contractor. All site conditions shall be field verified by Engineer/Surveyor/Contractor.

1.1 MINIMUM STANDARDS FOR STORM SEWERS

- A. Refer to the City of Westfield Stormwater Management Technical Standards Manual, latest version, for additional details and specifications.

PART 2 - PRODUCTS

2.1 BEDDING

- A. Class I bedding shall be angular 6 to 12 mm (1/4 to 1/2 inch) graded stone and crushed stone.
- B. Class II bedding shall be coarse sands and gravels with maximum particle size of 20 mm (3/4 inch). Class II bedding includes variously graded sands and gravels containing small percentage of fines generally granular and non-cohesive, either wet or dry. Soil types GW (well-graded gravel), SW (well-graded sand), and SP (pea gravel and/or crushed stone mixed with sand) are included in this class.

2.2 BACKFILL

- A. General: Backfill for utilities shall be in accordance with Westfield Construction Standard Drawings (WCSD) 02222-001 and 002.
- B. Non-Structural Backfill: Excavated material shall be used when earth backfill is specified on the plans or where granular backfill or flowable fill is not specifically specified, provided that such material consists of loam, clay, or other materials which, are suitable for backfilling. Unsuitable backfill or frozen backfill material shall not be used. Suitable backfill shall be the following soils, classified by the Unified Soil Classification System, ASTM D2487.
- C. Structural Backfill: Granular backfill, when indicated on the plans or as directed by the Engineer, shall be used for backfilling providing it meets the following soils classified by the Unified Soils Classification System ASTM D2487 or the INDOTSS Section 211 - B Borrow and Structural Backfill. For trenches less than 6" in width (i.e. cutting in water line services), uncompacted No. 8 stone may be used.
- D. Unsuitable Materials: Materials which are unsuitable for backfill include stones greater than 8 inches in their largest dimension, pavement, rubbish, debris, wood, metal, plastic, peat, and soils, classified by the Unified Soil Classification System, ASTM D2487. Frozen materials in excess of 6" in size shall be considered unsuitable and shall be removed during backfill operations.
- E. Cellular Concrete (Grout): Light weight cellular concrete may be used for filling of abandoned sewers as a grouting mixture for filling voids and as a substitute for backfill concrete in tunnels or casing pipes. The cellular concrete shall be produced by blending preformed foam with cement-sand grout slurry to produce a concrete having a fresh weight per cubic foot of not less than 75 pounds.

F. Flowable Fill

1. Flowable fill shall be removable and in accordance with INDOTSS Section 213 and as specified herein.
2. Design: Mix design shall be required to be submitted and approved by the WPWD or designated engineer. The Contractor shall be required to provide test data from a laboratory which shows that the proposed mix design is in accordance with the requirements listed in this specification.

PART 3 - EXECUTION

3.1 EXISTING UTILITIES, STRUCTURES, AND PROPERTY

- A. All poles, fences, sewer, fiber optic, gas, water or other pipes, wires, conduits and manholes, wells, septic systems, wetlands, regulated drains, sink holes and other under-ground structures, railroad tracks, buildings, structures and property along the routes of water mains, force mains, and sewers shall be supported and protected from damage by the Contractor.
- B. Movable items such as mail boxes may be temporarily relocated during construction. Place movable items in their original location immediately after backfilling is completed, unless otherwise shown on the drawings. Movable items which are damaged during construction will be replaced with similar material at the Contractor's expense.
- C. The Contractor shall proceed with caution in the excavation and preparation of trenches so that the exact location of underground utilities and structures both known and unknown may be determined. Contractor shall call in utility locations to be marked prior to any construction activities. The Contractor shall be responsible for the repair of utilities and structures when broken or otherwise damaged at the direction of the utility company's representative. Contractor shall immediately contact utility company when damage has occurred.
- D. **All abandoned water wells must be plugged by a licensed water well driller in accordance with 312.IAC 13.Rule 10. A copy of the state form for abandoned wells must be provided to our office. If well was abandoned prior to 1998 then no form is required. All abandoned water wells to be inspected by the Hamilton County Health Department.**

- E. Whenever, in the opinion of the WPWD, it is necessary to explore and excavate to determine the location of underground structures, the Contractor shall make explorations and excavations for such purpose at the expense of the Developer/Contractor. If a City project, it will be at the cost of the Contractor.
- F. Wherever sewer, gas, water, or other pipes or conduits cross the trench, the Contractor shall support said pipes and conduits without damage to them. The manner of supporting such pipes, etc., shall be subject to the approval of the owner of the utility involved.
- G. When utility lines that have to be removed or relocated are encountered within the areas of operations, the Contractor shall notify the WPWD or the owner of that utility in ample time for the necessary measure to be taken to prevent interruption of the service.
- H. The Contractor shall so conduct the work that no equipment, material, or debris will be placed or allowed to fall upon private property in the vicinity of the work unless they shall have first obtained the property owner's written consent thereto and shall have provided a copy of said written consent to the City.
- I. All excavated material shall be piled in a manner that will avoid obstructing sidewalks and driveways. Line of sight for vehicles and pedestrians shall not be obstructed. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, fire and police call boxes, or other utility controls shall be left unobstructed and accessible until the work is completed. Curb and gutters shall be kept clear and other satisfactory provisions made for street drainage, and natural watercourses shall not be obstructed.
- J. All streets, alleys, pavements, parkways, and private property shall be thoroughly cleaned of all surplus materials, earth, and rubbish placed thereon by the Contractor. Any debris, rubbish, earth, or material shall not be stored within the roadway.

3.2 CLEARING

- A. Clear and remove logs, stumps, brush, vegetation, rubbish, and other perishable matter from the project site as required to perform work.
- B. Do not remove or damage trees that do not interfere with the work. Completely remove trees required to be removed, including stumps and roots. Properly treat damaged trees which can be saved.

- C. Debris from the tree removal, including trunk, branches, leaves, roots and stumps, shall not be buried or burned on the job site, but must be completely hauled away and disposed of at the Contractor's expense.
- D. Clear and remove trees, logs, stumps, brush, vegetation, rubbish, and other perishable matter from the existing and proposed right of way.

3.3 STRIPPING AND STOCKPILING OF TOPSOIL

- A. Strip topsoil and vegetation from the excavated areas. Clean topsoil may be stockpiled for reuse as the upper 6 inches of the areas to be seeded. Soil stockpiles must be seeded if undisturbed for a period of time greater than 14 days per Stormwater Manual.

3.4 PAVEMENT AND SIDEWALK REMOVAL

- A. Remove existing pavement and sidewalks from the excavated areas. Remove excavated asphaltic and concrete materials from the job site as these materials are excavated.
- B. The width of pavement removed along the normal trench for the installation of pipe and structures shall not be less than two (2) feet on either side of the trench. Remove all existing pavement when the excavation requires the removal of 75% or more of the total existing pavement width. If over 50% of one travel lane is disturbed, restoration must be extended to the centerline of the roadway.
- C. Remove trails completely when excavation is along the length of a trail and requires the removal of part of the trail. Remove sidewalks to existing joints in the sidewalks when excavation crosses sidewalks. If there are no joints in an existing sidewalk or trail, the width of the sidewalk or trail removed shall not exceed the width of the trench by more than 12 inches on each side of the trench.
- D. Use methods to remove pavement and sidewalks that will assure the breaking or cutting of pavement and sidewalks along straight lines. The face of the remaining pavement and walk surfaces shall be approximately vertical.
- E. All concrete sidewalk and asphalt trails removed must be replaced per WPWD Standards Sections 02500 and 02505 and meet the most current ADA/PROWAG Standards. All restoration work shall require inspection by WPWD.

- F. Any area within existing pavement and/or sidewalks and trails to 5' from outside of pavement edge or back of curb shall have Removable Flowable Backfill as the fill material for the excavated area.

3.5 EXCAVATING

- A. General: After stripping of topsoil and vegetation, perform excavations of every description regardless of material encountered within the grading limits of the project to lines and grades as indicated on the drawings or as otherwise specified.
 - 1. Materials removed below the depths indicated shall be replaced to the indicated excavation grade with satisfactory bedding materials placed and compacted. The Contractor will minimize over excavation.
- B. Dewatering: Keep excavations free from water until the storm sewers, structures, foundations, and appurtenances to be constructed in the excavations are completed and will safely withstand forces from water. Provide sufficient dewatering equipment and make satisfactory arrangements for the disposal of the water without undue interference with other work, damage to property, or damage to the environment.
 - 1. Operate dewatering equipment ahead of pipe laying and keep the water level below the pipe invert until the pipe is secured by backfill.
- C. Trenching: Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.
 - 1. Latest version of OSHA rules and regulations Part 1926 shall be followed and adhered to in addition to conditions below. OSHA standards shall take precedent if a conflict exists.
 - 2. Do not open more than 100 feet of trench in advance of the installed pipe. Excavate the trench within 6 inches of full depth for a distance of at least 30 feet in advance of the pipe laying, unless otherwise directed or permitted.
 - 3. Contractor shall be responsible for the determination of the angle of repose of the soil in which the trenching is to be done. Excavate all slopes to at least the angle of repose except for areas where solid rock allows for line drilling or presplitting, or where shoring

or trench box is to be used. Contractor is responsible for ensuring all excavation is safe and in compliance with OSHA regulations.

4. Sides, slopes, and faces of all excavations shall meet accepted OSHA requirements by scaling, benching, barricading, rock bolting, wire meshing or other equally effective means. Give special attention to slopes which may be adversely affected by weather or moisture content.
5. Flatten the trench sides when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.
6. Shoring, sheeting, trench box, or other means shall be used to support sides of trenches in hard or compact soil when the trench is more than 5 feet in depth and 8 feet or more in length. Sides of trenches shall include embankments adjacent to trenches. In lieu of shoring, the sides of the trench above the 5-foot level may be sloped to preclude collapse, but shall not be steeper than a 1-foot rise to each 1/2-foot horizontal. Provide a bench of 4 feet minimum at the toe of the sloped portion of the trench wall when the outside diameter of the pipe to be installed is greater than 6 feet.
7. Use diversion ditches, dikes, or other suitable means to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Do not allow water to accumulate in an excavation. If possible, the grade should be away from the excavation.
8. Excavations shall be inspected by a competent Contractor's representative after every rainstorm or other hazard-increasing occurrence, and the protection against slides and cave-ins shall be increased, if necessary.
9. Do not store excavated or other material nearer than 4 feet from the edge of any excavation. Store and retain materials as to prevent materials from falling or sliding back into the excavation. Install substantial stop log or barricades when mobile equipment is utilized or allowed adjacent to excavations.
10. The width of trenches in earth for storm sewers, basin connections, house connections, and other drains up to and including 33 inches in internal diameter shall provide a clearance of not less than 8 inches or more than 10 inches on each side of the pipe. Trenches for pipe larger than 33 inches in internal diameter shall provide a

clearance of not less than 10 inches or more than 14 inches on each side of the pipe.

11. The maximum clear width of trenches in earth for manholes shall be the greatest external width of the structure plus the space necessary for the construction and removal of the forms and construction of masonry work.
12. The design of the storm sewer pipe and structures is predicated upon the width of trench specified in this Article. The Contractor shall be responsible for the provision and installation, at his own expense, of such remedial measures as may be directed by the WPWD, designee, or utility company representative; should the trench width limits specified in this Article be exceeded.
13. Test the air in excavations in locations where oxygen deficiency or gaseous conditions are possible. Establish controls to assure acceptable atmospheric conditions. Provide adequate ventilation and eliminate sources of ignition when flammable gases are present. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, and basket stretcher, shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.
14. Provide walkways or bridges with guardrails where employees or equipment are required or permitted to cross over excavations.
15. Provide ladders where employees are required to be in trenches 4 feet deep or more. Ladders shall extend from the floor of the trench to at least 3 feet above the top of the excavation. Locate ladders to provide means of exit without more than 25 feet of lateral travel.
16. Provide adequate barriers and physically protect all remotely located excavations. Barricade or cover all wells, pits, shafts, and similar excavations. Backfill temporary wells, pits, shafts, and similar excavations upon completion of exploration and similar operations.
17. All open excavations shall be permanently backfilled within 48-hours of the opening of the excavation. During this time, adequate protection, in accordance with OSHA requirements, shall be required. Snow Fencing, or equivalent; no caution tape will be permitted.

- D. Quicksand: Carry on the work with utmost vigor and proceed with the work expeditiously when running sand, quicksand, or other bad or treacherous ground is encountered. Install bedding to support the pipe as directed.
- E. Blasting: Removal of rock from the excavation may be facilitated by the use of controlled explosives with WPWD approval.
 - 1. Blasting supervision and Blasting Monitoring and Control Programs shall meet the requirements of this Section.
 - 2. Storage procedures for explosives shall be developed by the Contractor and submitted to the Engineer before explosives are brought to the job site.

3.6 SHEETING

- A. The Contractor shall be responsible for construction means, methods, techniques, and procedures, and for providing a safe place for the performance of the work by the Contractor, Subcontractors, suppliers and their employees, and for access use, work, or occupancy by all authorized persons.
- B. The Contractor shall be solely responsible for all obligations prescribed as employer obligations under Chapter XVII of Title 29, Code of Federal Regulations, Part 1926, otherwise known as "Safety and Health Regulations for Construction."
- C. Adequate supporting systems, such as sheeting, shoring, piling, cribbing, and bracing shall be furnished and installed by the Contractor as required to protect existing buildings, utilities, and property from damage during the progress of the work.

3.7 STORAGE AND REMOVAL OF EXCAVATED MATERIAL

- A. Suitable excavated material required for filling and backfilling operations may be stockpiled in on-site locations, at the discretion of the WPWD or designee, until the material is ready to be placed.
- B. Remove unsuitable materials from the job site as unsuitable materials are excavated. Remove surplus suitable materials from the job site as trenches are backfilled.

3.8 TEMPORARY PLUGS

Prevent foreign material from entering pipe while it is being installed. Do not place debris, tools, clothing, or other material in the pipe. Close the open ends of

pipe by securing watertight plugs when pipe laying is not in progress. Remove any earth or other material that enters pipe, lateral pipe, or appurtenances through any open pipe end.

3.9 BACKFILLING WATER MAIN, SANITARY MAIN, FORCE MAIN, AND STORM SEWER TRENCHES

- A. Backfilling of water main, sanitary main, and force main trenches shall meet the requirements of ANSI/AWWA C600, unless otherwise specified in this Section. Backfilling of storm sewer trenches shall be in accordance with INDOTSS 715.
- B. Do not backfill trenches and excavations until all utilities have been inspected by the WPWD or designee and until all underground utilities and piping systems are installed in accordance with the requirements of the specifications and the drawings. Required hydrostatic tests may be applied to the line either before and/or after the trench is backfilled, subject to approval of the WPWD or designee.
- C. Bedding procedures for sanitary sewers and storm sewers shall be as specified in Manufacturer's recommendation, or WPWD specifications. The more stringent specification will apply. Place and tamp bedding and backfill in a manner which will not damage pipe coating, wrapping, or encasement.
- D. Material from the trench subgrade to the centerline of the pipe shall be Class II bedding. Place bedding by hand or approved mechanical methods in layers of 8 inches loose depth. Compact bedding by hand tamping or with a power operated hand vibrating compactor. Deposit bedding in the trench for its full width on each side of the pipe simultaneously.
- E. Compaction shall be in accordance with INDOTSS 211.
- F. Do not use the following materials for backfill:
 - 1. Unsuitable materials;
 - 2. Frozen materials;
 - 3. Materials which are too wet or too dry to be compacted to the densities specified in this Article;
 - 4. Flowable concrete fill shall not be in direct contact with ductile iron or other metallic pipe materials and/or fittings. Minimum separation of 12 inches shall be maintained.
- G. Where the edge of the trench is within 5 feet of the existing pavement or public right-of-way, it shall be backfilled with Structural Backfill in accordance with INDOTSS 211, unless otherwise approved in writing by

the WPWD Engineer. For all new construction, refer to WSD 02222-001 and 002 for backfill limits and requirements. A WPWD Inspector shall be notified 24-hours in advance of the backfilling of all utility crossings of new infrastructure. For all open cuts of existing pavement infrastructure, refer to WSD 02222-002. All restoration of open roadway cuts shall be fully restored within 48-hours of the open cut of the existing infrastructure.

- H. All sanitary and water crossings of existing public roadway infrastructure shall NOT be installed with an open cut trench. Trenchless installation shall be required per INDOTSS 716, unless otherwise approved in writing by the WPWD Engineer.

3.10 FLUSHING OF WATER MAINS

- A. All flushing of water mains for testing purposes, if chlorinated, shall be required to outlet directly to the nearest sanitary sewer structure. Any water chlorinated for testing purposes shall be dechlorinated prior to draining into storm sewer system.

3.11 LEAKAGE TESTING FOR WATER AND SANITARY

- A. All leakage testing for water and sanitary shall be completed and accepted prior to placement of any asphalt, unless otherwise approved in writing by the WPWD Engineer.

3.12 MAINTAINING TRAFFIC

- A. Developer is responsible for preparing maintenance of traffic plans for any construction activities that will interfere with public transportation. These maintenance of traffic plans must be included in the construction plans that are submitted to the City. The City will provide maintenance of traffic plans associated with City projects unless otherwise specified in the contract. If there are modifications to the maintenance of traffic plans, it must be reviewed by the City prior to implementation.
- B. Before closing any thoroughfare, the Contractor shall notify and, if necessary, obtain permit(s) from the duly constituted public authority having jurisdiction, which may include the state, county, and city/town. The contractor will be responsible for notifying the local school corporation, all public safety agencies, government agencies, and any affected property owners. The Contractor shall provide the WPWD a detour route plan for review prior to the road closure at least 5 business days in advance of the On or After closure date. The Contractor shall place approved advanced road closure signs and detour route signs a minimum 72 hours in advance of the On or After closure date. The

Contractor shall notify the City a minimum of 48 hours in advance of the actual closing of the roadway.

- C. During the construction, the Contractor shall be responsible for maintaining and protecting the pedestrian and vehicular traffic at all times on all streets involved and providing access to all residential and commercial establishments adjacent to the construction area. Emergency vehicle access must be maintained at all times. The Contractor shall furnish and maintain signage, barricades, flares, etc., in accordance with the latest version of the Indiana Manual on Uniform Traffic Control Devices. The signage, barricades, etc., must be in good condition and the City has the right to reject if determined to be in less than good condition.
- D. The Contractor shall conduct his work in such a manner as not to unduly or unnecessarily restrict or impede normal traffic through the streets of the community. Insofar as it is practicable, do not locate excavated material and spoil banks in such manner as to obstruct traffic. Keep the traveled way of all street, roads, and alleys clear and unobstructed insofar as is possible. Do not use streets, roads, or alleys for the storage of construction materials, equipment supplies, or excavated earth, except when and where approved by the WPWD. If required by duly constituted public authority, the Contractor shall, at his own expense, construct bridges or other temporary crossing structures over trenches so as not to unduly restrict traffic. Such structures shall be of adequate strength and proper construction and shall be maintained by the Contractor in such manner as not to constitute an undue traffic hazard. Private driveways shall not be closed, except when and where necessary, and then only upon due advance notice to the WPWD and Homeowner or Business owner, and for the shortest practicable period of time, consistent with efficient and expeditious construction. The Contractor shall be liable for any damage to persons or property resulting from his work.
- E. Streets in which excavation has occurred shall be temporarily restored to receive traffic as soon as possible. Permission to close additional streets shall be denied if, in the opinion of the City, the restoration on streets where excavation has occurred has not progressed satisfactorily.

3.13 SIDEWALKS AND PASSAGEWAYS

The Contractor, when required, shall make provisions at cross streets for the free passage of vehicles and foot passengers, either by bridging or otherwise. Do not obstruct the sidewalks, gutters, or streets, or prevent in any manner the flow of water in streets. Use all proper and necessary erosion and sediment control measures as required within the Standards Manual to permit the free passage of surface water along the gutters. The Contractor shall immediately remove all material, exercising such precaution as may be directed by the City. All material

excavated shall be so disposed of as to inconvenience the public and adjacent tenants as little as possible and to prevent injury to trees, sidewalks, fences, and adjacent property of all kinds. The Contractor may be required to erect suitable barriers to prevent such inconvenience or injury.

3.14 WARNING LIGHTS

The Contractor shall place sufficient warning lights on or near the work and keep them illuminated during periods of reduced visibility (from twilight in the evening until sunrise) and will be held responsible for any damages that any party or the City may sustain in consequences of neglecting the necessary precaution in prosecuting this work.

3.15 CLEANUP AND MAINTENANCE

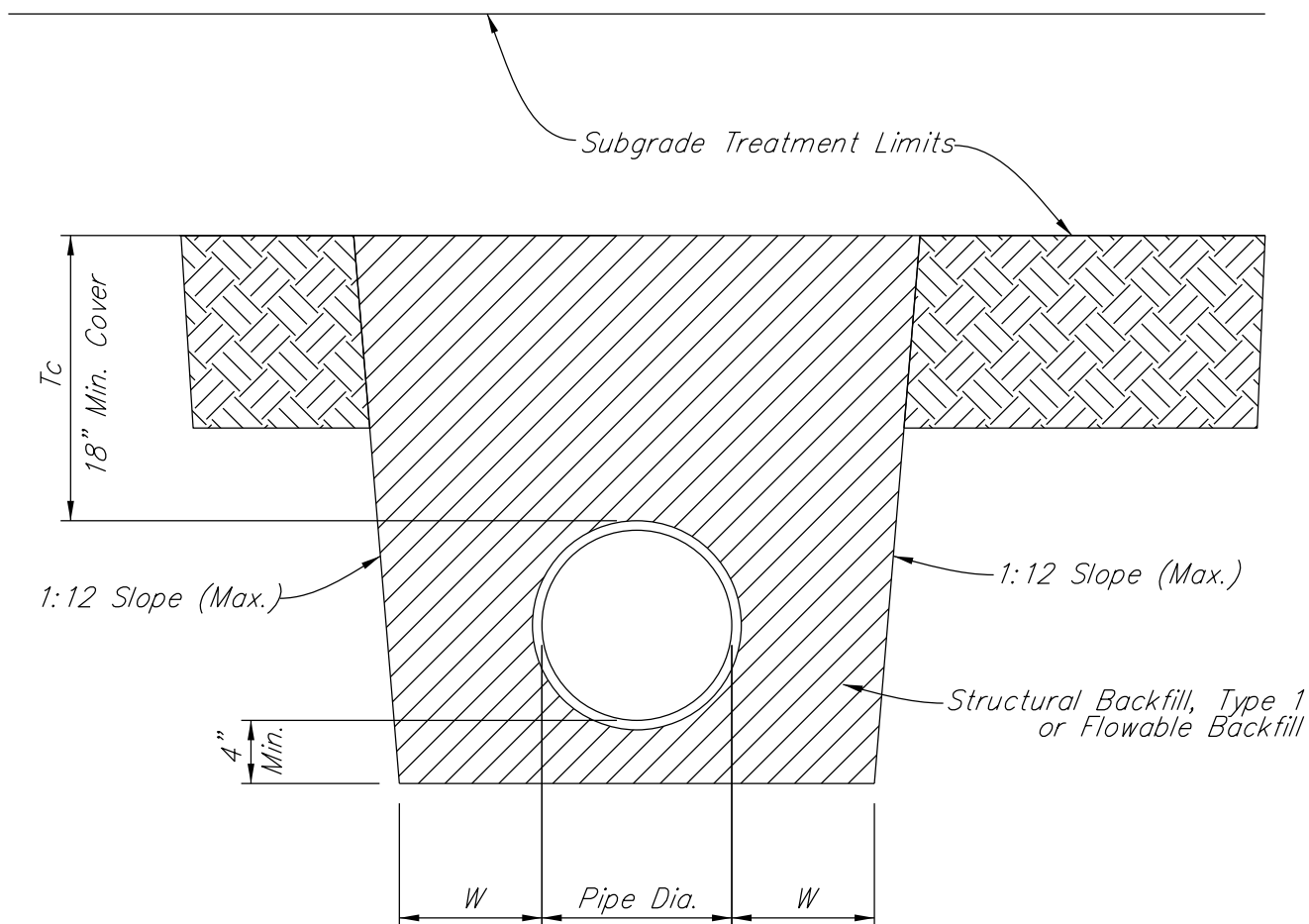
- A. Cleanup the job site as backfilling is completed. Remove excess earth, rock, bedding, materials, and backfill materials. Remove unused piping materials, structure components, and appurtenances. Restore items moved, damaged, or destroyed during construction. Grade area to be restored. Leave backfill mounded over trenches which are not backfilled with Structural Backfill. Cleanup and restoration specified in this paragraph shall be completed within 1,000 feet of excavation.
- B. Restoration of grass, bushes, trees, and other plants shall be completed by Contractor to original or better condition.
- C. Maintain the job site until the work has been completed and accepted. Fill trenches which settle when settlement is visible. Restore items damaged by construction or improper restoration. Keep dust conditions to a minimum by the use of water.

PART 4 - FIGURES

4.1 STANDARD PAVEMENT DETAILS

<u>FIGURE</u>	<u>DESCRIPTION</u>
02222-001	Utility Backfill Details
02222-002	Utility Backfill Limits
02222-003	Utility Pothole Details

END OF SECTION 02222



NOTES:

$W = 0.3 \times \text{Pipe Diameter or } 9" \text{ Min.}$

T_c = Structural Backfill Shall Extend to Bottom of Subgrade Treatment Limits, 18" Min.

All Backfill Shall Be In Accordance with INDOTSS 715.

Compaction Shall Be In Accordance with INDOTSS 211.

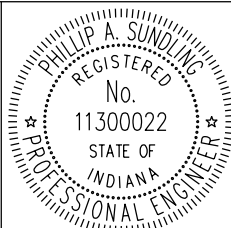
For Non-Pavement Applications, Min. Structural Backfill

Over Pipe Shall Be 6". The Remaining Portion of Backfill

May Be Non-Structural In Accordance with Westfield Standards and Specifications 0222-2.2B.

UTILITY BACKFILL DETAILS

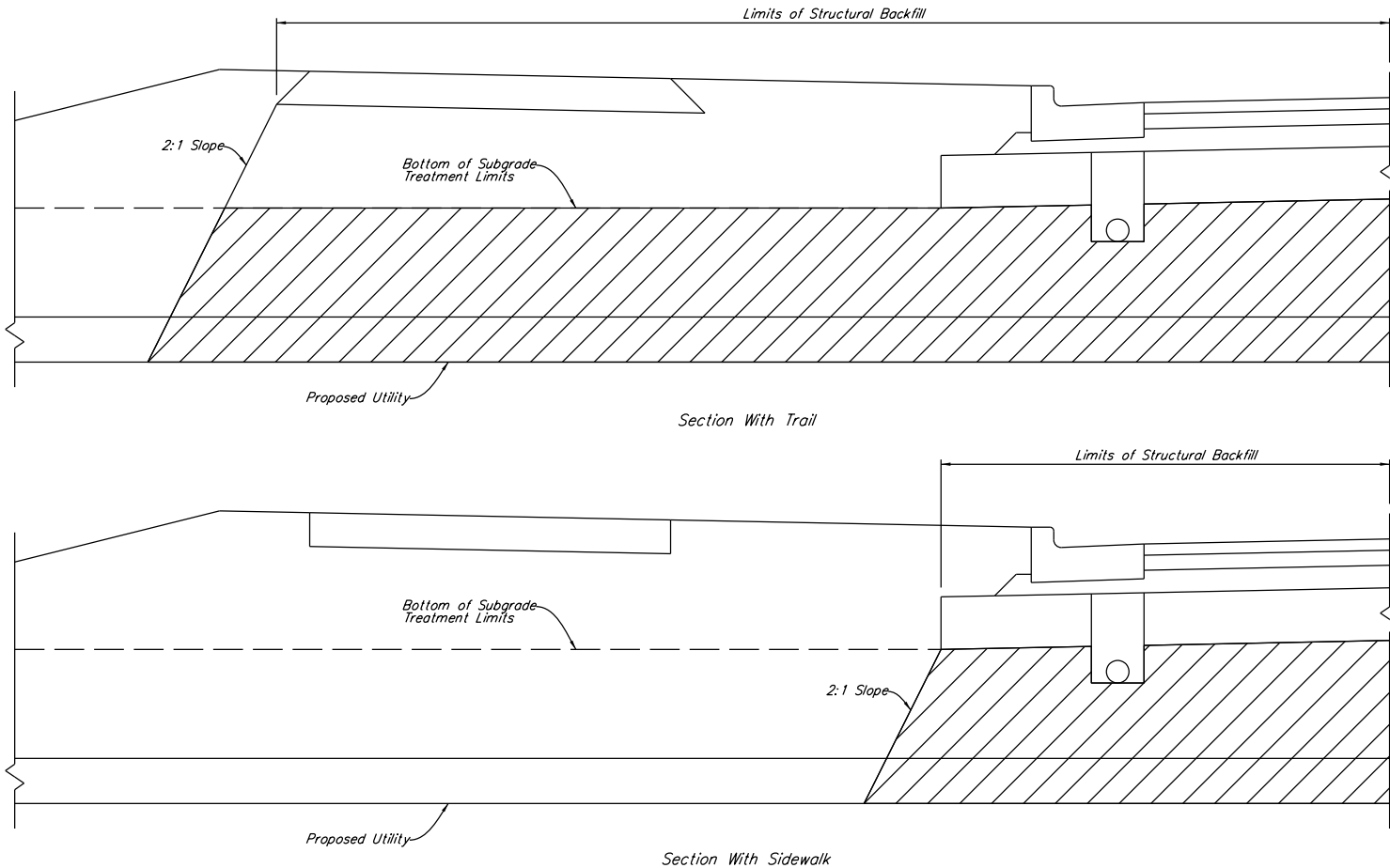
CITY OF WESTFIELD, INDIANA



Phillip A. Sundling

2/10/17
DATE

FIGURE 2222-001



Structural Backfill Limits

UTILITY BACKFILL LIMITS



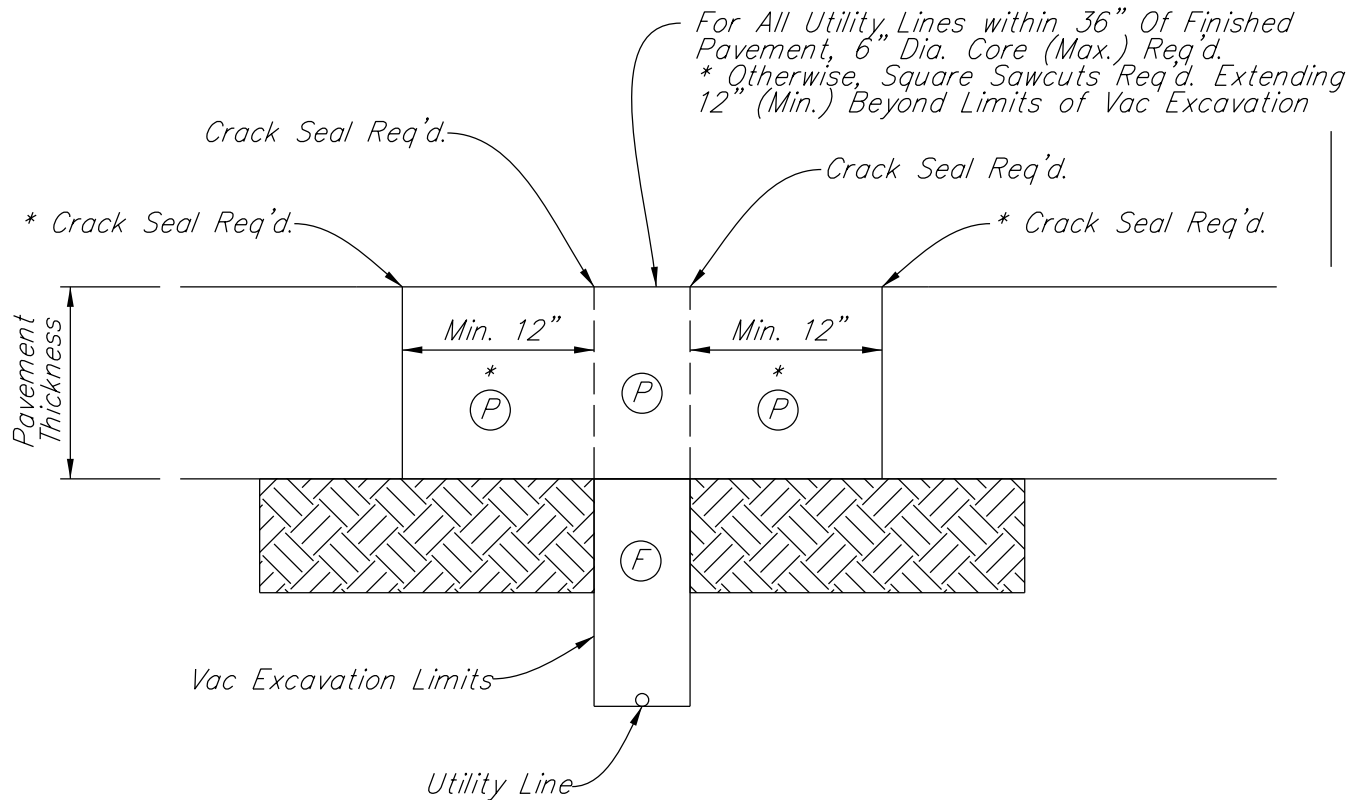
Phillip A. Sundling

2/29/16
DATE

CITY OF WESTFIELD
INDIANA

FIGURE 2222-002

For All Patches 4'x4' Or Greater In Size, 1.5" Mill and Resurface Req'd.
Limits To Extend Min. 10' Beyond Patching Limits, Full Lane Width.

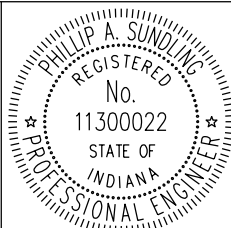


- (F) Non-Removable Flowable Backfill
- (P) HMA for Patching (Match Ex. Pavement Thickness, Min. 6")
- (R) 1.5" Mill and Resurface
165 #/SYS HMA (Type B for Collectors/Local and Type C for Arterials)

NOTES:
All Non-Removable Flowable Backfill Shall Be In
Accordance with INDOT 213.
All HMA for Patching and Resurfacing Shall Be In
Accordance with INDOTSS 402.

UTILITY POTHOLE DETAILS

CITY OF WESTFIELD, INDIANA



Philip A. Sundling

2/29/16
DATE

FIGURE 2222-003

SECTION 02310 – HORIZONTAL DIRECTIONAL DRILLING

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

The CONTRACTOR shall provide all investigation, planning, geotechnical work, equipment, labor, etc. necessary to properly install the proposed directional bores as indicated in the construction plans by using horizontal directional drilling (directional boring) technology. Pipe materials shall match those indicated on the plans.

1.2 SUBMITTALS

Work plans, shop drawings and manufacturer's literature shall be submitted to the WPWD for approval. Work plans shall include but not limited to the proposed construction plans, fluid plan, and a schedule for construction.

PART 2 – PRODUCTS

2.1 PIPE FOR HORIZONTAL DIRECTIONAL DRILLING

The following table indicates minimal material standards.

Material Type	Non- Pressure	Pressure
Polyethylene (PE)	ASTM D 2447	ASTM 2513, ASTM D 2447
High Density Polyethylene (HDPE)	ASTM D 2447, ASTM D 3350, ASTM F 714	ASTM D 2447, ASTM D 3350, ASTM F 714, ASTM 2513
Polyvinyl-Chloride (PVC)	ASTM F 789	ASTM D 1785, ASTM D 2241

2.2 JOINTS AND FITTINGS

All joints and fittings shall be watertight. Ensure that the joined pipes have adequate strength and flexibility to withstand the installation stresses, overburden pressures, and operating pressures without compromising the structural stability of the pipe wall. All fittings for force mains or pressure rated fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fittings as such.

2.3 DRILLING FLUIDS

Drilling fluid mixture shall consist of potable water and a stabilizing agent. The stabilizing agent shall be bentonite, polymer and/or approved equal. Drilling fluid

shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of the bore wall.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Depths of all existing utilities must be confirmed by the CONTRACTOR prior to the crossing to avoid conflicts. Equipment shall be utilized that does not require the conventional bore and receiving pits due to space constraints. Proper connection to the piping at each end shall be done by standard excavation. The CONTRACTOR shall be responsible to provide a slurry containment pit and shall remove all excess material and dispose of appropriately off-site upon completion. All erosion control facilities shall be provided to contain any solids from migrating beyond the project site. If the CONTRACTOR utilizes a subcontractor for this work, they shall provide proof of adequate comprehensive general liability insurance covering underground collapse and explosion and experience to the ENGINEER and OWNER for prior approval. The CONTRACTOR shall be required to provide all necessary water in accordance with other applicable sections of these specifications. Excavated areas for utility confirmation shall be properly backfilled per Section 02222.
- B. In all cases the manufacturer's recommendations and procedures shall be followed regarding the installation of their pipe material by horizontal directional drilling.
- C. Subsurface investigation, if deemed necessary, shall be provided prior to bids by the CONTRACTOR. No additional payments will be made if rock is encountered or if soil conditions require additional construction time and equipment. Proper equipment and methods shall be used in rock and soil bores to insure proper grades, elevations and separations.
- D. All directional drilling operations shall be performed by a qualified directional drilling CONTRACTOR with at least (3) years experience involving work of a similar nature to the work required of this project. The CONTRACTOR must have installed a minimum of 10,000 linear feet of pipe using directional drilling operations. A list of project references and proof of contractor experience shall be presented to the ENGINEER, upon request by the ENGINEER.
- E. The requirements of all applicable local and state authorities shall be followed by the CONTRACTOR.
- F. The piping shall be installed at a minimum depth of 6" below the sub-surface drain for all street crossings where sub-surface drain exists.

Contractor to verify if sub-surface drains are present prior to drilling operation. If sub-surface drain does not exist at a street crossing, the piping shall be installed at a minimum depth of 42”.

- G. Installations shall have a bored hole essentially the same diameter as the outside of the installed pipe. If voids develop or if the bored diameter is greater than the outside diameter of the pipe by more than 1 inch, grouting shall be used to fill such voids.
- H. Pavement or ground surface heave or settlement resulting in damage to pavement, curbs, sidewalks, existing utilities, or structures above or adjacent to the installation shall not be permitted.
- I. During installation of all pipes, a minimum of three, 12 gauge, locator wires shall be used.
- J. Take all necessary measures to eliminate the discharge of water, drilling mud, and cuttings to nearby waterways.
- K. If an obstruction is encountered during installation which stops the forward progress of the pipe, and it becomes evident that it is impossible to advance the pipe, the WPWD shall be notified.
- L. The WPWD shall be notified if a bore head is abandoned underground within the right of way.
- M. The CONTRACTOR shall provide accurate As-Built data based on downhole survey data or a walkover location system that indicates x, y and z coordinates of the pipe at least every thirty (30) feet along the alignment or at a midpoint if the bore length is less than thirty (30) feet.

3.2 TESTING

Test tracer wire continuity upon completion of work but before site restoration.

3.3 SITE RESTORATION

Once the work has been completed, the Contractor shall de-mobilize and restore the work site and all affected areas including but not limited to asphalt pavement, concrete surfaces, and areas within the right of way to the original condition or better within ninety (90) days. Temporary seeding shall be applied to any disturbed area that will remain undisturbed in excess of 15 days.

END OF SECTION 02310

SECTION 02500 – PAVING AND SURFACING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: This section covers all work involved in the installation of new pavement and the repair and replacement of existing streets, roads, highways, drives, parking areas and other paved areas damaged or destroyed during construction.
- B. New street pavement shall be asphalt only. Any reference to concrete pavement shall apply to the repair and maintenance of existing concrete streets only.
- C. Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the reference thereto. Except as specifically modified in this specification, paving and surfacing operations, materials and testing will comply with the most current revisions of applicable sections per the latest version of the Indiana Department of Transportation Standard Specifications.
- D. Definitions
 - 1. Abbreviations
 - a. INDOTSS - Indiana Department of Transportation's Standard Specifications.
 - b. AASHTO - American Association of State Highway & Transportation Officials.
 - c. ACI - American Concrete Institute.
 - d. ASTM - American Society for Testing & Materials.
 - e. NRMCA - National Ready Mix Concrete Association.
 - 2. Rock: A natural aggregate of mineral particles connected by strong and permanent cohesive forces. Rock includes limestone, sandstone, dolomite, granite, marble, and lava.
 - 3. Subgrade: The prepared and compacted soil immediately below the pavement or walk system and extending to such depth as will affect the structural design.
 - 4. Subbase: The layer of specified or selected material of designed thickness placed on a subgrade to support a base course and surface course.

5. Base Course: The layer of specified or selected material of designed thickness placed on a subbase to support a intermediate or surface course.
6. Intermediate Course: The layer of specified or selected material of designed thickness placed on a base course to support a surface course.
7. Surface Course: The layer of specified or selected material of designed thickness placed on a subbase or base course to support the traffic load.

1.2 QUALITY ASSURANCE

- A. The Developer/Contractor shall employ, at the request of the WPWD or designee, and pay for the services of an independent testing laboratory (unless otherwise noted) to perform specific services and necessary field density tests. The Developer/Contractor shall demonstrate to the WPWD or designee that proper compaction has been obtained and proper asphalt and concrete mix designs are in compliance with the specifications.
 1. Refer to INDOTSS 402.12 for Weather Limitations. Density testing will be required if temperatures conditions are not acceptable.
 2. HMA courses less than 110 lb/sq yd are to be placed when the ambient and surface temperatures are 60°F or above. HMA courses equal to or greater than 110 lb/sq yd but less than 220 220 lb/sq yd are to be placed when the ambient and surface temperatures are 45°F or above. HMA courses equal to or greater than 220 lb/sq yd and HMA curbing are to be placed when the ambient and surface temperatures are 32°F or above. Mixture shall not be placed on a frozen subgrade. However, HMA courses may be placed at lower temperatures, provided the density of the HMA course is in accordance with INDOTSS 402.16.
- B. Mixing Plant: Prior to placing any hot asphalt pavement or Portland cement concrete pavement, the Contractor shall provide the WPWD or designee the name and location of the bituminous mixing or concrete mixing plant and the type and composition of mixes the Contractor proposes to use in the work. Mix designs shall be submitted for review and approval a minimum of 5 business days before installation. Any unapproved mix placed by the Contractor shall be removed at no cost to the City of Westfield. There will be no exceptions.

- C. Paving and surfacing shall comply with the tolerances specified in Sections 401, 402, 501, and 502 of INDOTSS.
 - 1. Subgrade and subbase shall be within 1/2 inch of dimensions and elevations indicated on drawings.
 - 2. Bituminous base shall not vary longitudinally more than 1/4 inch from a 10-foot straightedge. Bituminous and concrete surfaces shall not vary more than 1/8 inch from a 10-foot straightedge.
 - 3. Finished surface shall be within 1/4 inch of dimensions and elevations indicated on drawings.
- D. Asphalt and concrete pavement shall be installed by a contractor whose prime business is asphalt or concrete paving.

1.3 JOB CONDITIONS

- A. Do not place paving and surfacing materials on a wet surface, pumping subbase or when weather conditions would prevent the proper construction of paving and surfacing.
- B. Do not place aggregates on frozen subgrade or subbase. Do not place aggregates when ambient air temperature in the shade is below 35°F. Refer to INDOTSS 301.04 for additional weather limitations.
- C. Bituminous materials are to be placed in accordance with INDOTSS Sections 401, 402, 405, and 406.
- D. Portland Cement Concrete Pavement is to be placed in accordance with INDOTSS Sections 501 and 502.
- E. When air temperatures are at or below 35 degrees F, an admixture is required to be added to the concrete to prevent freezing. Refer to INDOTSS 502.11 for weather limitations. Approval must be given prior to placement by the WPWD Inspector.
- F. Do not place paving and surfacing materials when natural light is not sufficient to properly observe work or operations. Light plants may be required for safety.

1.4 GRADE ADJUSTMENT OF EXISTING STRUCTURES

- A. When a grade adjustment of existing structures is required, the manhole frames, covers and gratings, and the gas and water valve boxes and covers,

shall be removed and reconstructed to grade as required with an approved device. Approved devices include, but not limited to:

1. Concrete riser ring
 2. Pro-Ring®
 3. Or Approved Equal
- B. Maximum amount of riser rings shall be only 12 inches or no more than 3 rings. Greater adjustment than 12 inches shall require a reconstruction of the structure, per INDOTSS 720.04.
- C. On resurfacing and new construction work, the manhole castings and valve boxes shall be adjusted to grade flush with pavement using “Mr. Manhole” or similar approved system after the surface course is installed.

1.5 CONTRACTOR'S ORGANIZATION

- A. The Contractor shall be a firm whose prime business is asphalt or concrete paving. The Contractor shall have a competent supervisor on the site during the progress of the work, acting for the Contractor in all matters concerning the work. He shall have the authority to receive directions and act upon them for the City through the WPWD or designee.
- B. The Contractor shall keep a set of Plans and Specifications available on the site and in good condition.

1.6 TRAFFIC CONTROL

- A. The Developer's Engineer shall plan construction operations so that existing local traffic access can be maintained. If a closure is required, refer to General Requirements, Section 00300.
- B. During the construction, the Contractor will also maintain appropriate use of barricades, lights, flagmen and other protective devices, whether specified for the project or required by the local governing authority. Traffic control devices used for maintenance of traffic shall comply with the latest version of the Indiana Manual on Uniform Traffic Control Devices.
- C. Temporary pavement markings shall be required after milling operations and before resurfacing if left exposed for over 24 hours. Contractor may be required to place cones or approved barricades after temporary markings are pulled and before asphalt is placed.
- D. Temporary pavement markings shall be required after paving operations until permanent markings can be placed, or for the purpose of temporarily

shifting traffic patterns. If permanent markings will not be placed until after the winter season, temporary markings shall be paint or thermoplastic by a qualified contractor.

- E. Asphalt Tapers at all butt joints shall be required if opened to live traffic. Millings are not acceptable.

PART 2 - PRODUCTS

2.1 AGGREGATE

- A. Fine aggregates shall consist of natural sand or manufactured sand produced by crushing rock, shells, air-cooled blast furnace slag, or wetbottom boiler slag.
 - 1. Fine aggregates used in Portland cement concrete and bituminous pavements shall be free from injurious amounts of organic impurities. When subjected to the colorimetric test for organic impurities and a color darker than the standard is produced, it shall be tested for effect of organic impurities on strength of mortar in accordance with AASHTO T 71. If the relative strength at 7 and 28 days, calculated in accordance with section 10 of T 71, is less than 95%, it shall be rejected.
- B. Coarse aggregates shall consist of clean, tough, durable fragments of crushed rock, crushed or uncrushed gravel or shells, or crushed and processed air-cooled blast furnace slag. These materials shall not contain more than 15% flat or elongated pieces and shall not contain particles with an adherent coating. Flat or elongated pieces will be described as pieces having a length in excess of four times its width.
- C. Aggregates shall comply with INDOTSS Section 904.

2.2 BITUMINOUS MATERIALS

- A. Petroleum asphalt cement shall be homogeneous, free from water, and shall not foam when heated to 347°F.
 - 1. Petroleum asphalt cement shall be PG Binder, grade PG 64-22.
 - 2. Petroleum asphalt emulsion shall be AE-60.
- B. Bituminous materials for prime coat shall consist of:
 - 1. Asphalt emulsion - AE-P.
 - 2. Asphalt emulsion – AE-PMP.
 - 3. Prime Coat shall conform to INDOTSS Section 405.

- C. Bituminous materials for tack coat shall consist of:
 - 1. Asphalt emulsion - AE-T, AE-PMT, SS-1h, AE-NT.
 - 2. Tack Coat shall conform to INDOTSS Section 406.
 - a. Type A Cert Required per INDOTSS 406.02.
- D. Bituminous materials for seal coat shall consist of:
 - 1. Asphalt emulsion - RS-2, AE-90, AE-90S, HFRS-2.
 - 2. Materials shall conform to INDOTSS Section 902.
- E. Cover aggregate shall be in accordance with INDOTSS 404.04.
- F. Joint Adhesive shall consist of:
 - 1. Materials shall conform to INDOTSS Section 906.
 - a. Type A Certification Required

2.3 HOT MIX ASPHALT (HMA)

- A. Hot mix asphalt (HMA) shall consist of an intimate mixture of coarse aggregate, fine aggregate (including mineral filler if required), and asphalt cement or emulsion combined in proportions specified in INDOTSS 401. Acceptance shall be in accordance with INDOTSS 402.
- B. When the use of one type or source of aggregate or binder is started, the use of that same type or source shall be continued for the entire lift being constructed, unless otherwise directed by the Engineer.
- C. The use of recycled materials, RAP, shall be permitted per current INDOT standards.
 - 1. No mixes will be approved with RAP exceeding 25.0%
- D. HMA mix design shall be submitted for review and approval a minimum of 5 business days prior to placement of any asphalt.
- E. Preparation of HMA mixtures shall comply with the requirements of INDOTSS Section 402.

2.4 PORTLAND CEMENT CONCRETE

- A. Cement shall be Portland cement and shall meet the requirements of ASTM C 150, ACI 301, and ACI 318. Cement shall be Type 1 for normal use, Type 1A where air entrainment is desired, or Type III or Type IIIA

where high early strength is desired and authorized by the Engineer. Blended hydraulic cements which meet the requirements of ASTM C 595 Type 1P Portland pozzolan cement may be used where a more watertight concrete is required. Fly ash may also be used as a partial cement replacement for Types 1 or 1A in accordance with INDOTSS 502.04. Fly Ash may only be used between April 1 and October 15. Cement shall meet requirements specified in INDOTSS Section 901.

- B. Regular fine and coarse aggregates shall meet the requirements of ASTM C 33. Aggregate shall be crushed limestone with a maximum size of 3/4 inch, except in mass concrete the maximum size may be 1 1/2 inches.
 - 1. Lightweight fine and coarse aggregates shall meet the requirements of ASTM C 330.
 - 2. Insulating fine and coarse aggregates shall meet the requirements of ASTM C 332.
- C. Water shall be potable, clean, and free from injurious amounts of oils, acids, alkalis, organic materials, or other substances that may be deleterious to concrete or steel. A maximum of 500 mg/L of chloride ion may be present in the water.
- D. Air entraining admixtures shall meet the requirements of ASTM C 260.
 - 1. Water reducing and retarding admixtures shall meet the requirements of ASTM C494, Type A or Type D; however, they shall contain no chlorides, be nontoxic after 30 days and compatible with the air entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's requirements. Furnish a compliance statement that the admixture used satisfies all requirements of this specification. Evidence that the admixture is included in the approved list of the INDOTSS Division of Materials and Tests, in accordance with INDOTSS Section 912, will satisfy the requirement for a compliance statement.
 - 2. Fly ash shall meet the chemical and physical requirements of ASTM C 618 for mineral admixture Class F, except loss on ignition shall not exceed 6%. Fly ash shall be sampled and tested in accordance with ASTM C 311 prior to use.

- E. Reinforcing steel shall meet the requirements of ASTM A 615, Grade 60.
 - 1. Welded wire fabric or wire mesh shall meet the requirements of ASTM A 185.
 - 2. Reinforcing steel and appurtenances shall follow INDOTSS Section 910.
- F. Preformed expansion joint filler shall meet the requirements of ASTM D1752, Type III.
 - 1. Hot-poured elastic joint filler shall meet the requirements of ASTM D1190.
 - 2. Waterproof expansion joint filler shall meet the requirements of ASTM D1850.
 - 3. Joint materials specified in INDOTSS Section 906 may be used, approved by the Engineer.
- G. Concrete pavement shall be wet cured by using burlap, waterproof blankets, or ponding; or by using a membrane compound. If the membrane method is used, the compound shall be Type 2, complying with AASHTO M148 for white pigmented compound. A pressure sprayer capable of applying a continuous uniform film to the pavement surfaces will be required.
 - 1. Dowel bars and assemblies shall conform to the requirements of INDOTSS Section 503.
- H. Concrete base shall meet the requirements of INDOTSS Section 305.
- I. Reinforced concrete pavement shall meet the requirements of INDOTSS Section 501.
- J. Reinforced concrete for sidewalks and steps shall meet the requirements of INDOTSS Section 604.
- K. Reinforced concrete for curbing shall meet the requirements of INDOTSS Section 605.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is responsible to provide equipment, workmanship and materials required to achieve a finished product that meets these specifications.

- B. Compaction equipment shall be in accordance with INDOTSS.
- C. Prior to placing paving and surfacing materials, shape subgrade as required to produce finished pavement grades and cross-sections shown on drawings.
- D. Do not place paving and surfacing material before subgrade is reviewed via proof roll or other approved method and accepted by the WPWD or designee. Do not place paving and surfacing materials on a frozen or muddy subgrade in accordance with INDOTSS Sections 203, 207, 302 and 401, and 402.
- E. Compact subgrade to not less than 100% of its maximum density as determined in accordance with AASHTO T99 and INDOTSS 207.
- F. Provide adequate drainage at all times to prevent water from standing on subgrade, pavement or walks. Sufficient effort shall be made to ensure subgrade is well drained. Mechanical dewatering may not be required.

3.2 SUBGRADE

The subgrade material and testing shall comply with INDOTSS Section 207, before placement of subbase.

3.3 SUBBASE PREPARATION

Subbase shall meet the requirements of INDOTSS Section 302.

3.4 AGGREGATE BASE, SURFACE, OR SHOULDERS

- A. Aggregate base, surface, or shoulders shall consist of crushed rock or gravel. The aggregate type shall be suitable for the area in which the project is located. The aggregate thickness shall be as shown on the drawings and as specified herein.
- B. Aggregate shall be Compacted Aggregate, No. 53, Base in accordance with INDOTSS 301, unless otherwise specified or approved in writing by the WPWD.
- C. If the required thickness of the aggregate section exceeds 6 inches, the material shall be placed and compacted in separate lifts no less than 3 inches nor more than 6 inches of compacted depth.
- D. If spreading devices are used which will ensure proper depth and alignment, forms will not be required; otherwise forms shall be required.

Forms shall be of wood or steel, adequate in depth, straight, of uniform dimensions and equipped with positive means for holding the form ends rigidly together and in line. Segregation of material shall be avoided by any spreading method used. No payment will be made for aggregate placed beyond the dimensions shown on the drawings.

- E. Compact material in each lift after material is spread and shaped. Compact material to not less than 100% of maximum dry density as determined by AASHTO T99 in accordance with INDOTSS 301.06. Use construction procedures, including sufficient moisture adjustments and number of passes, to ensure specified density is attained.
- F. The Contractor shall employ an independent testing laboratory to perform field density tests to demonstrate proper compaction of aggregate surface pavement, if requested by the WPWD or designee.
- G. Unless otherwise shown on the drawings, the minimum section (excluding subgrade) of reinforced concrete shall be 6 inches of Compacted Aggregate, No. 53, Base and 6 inches of 4,000 psi reinforced Class "A" concrete.
- H. Unless otherwise shown on the drawings, for a street with a concrete base and an asphalt surface, the replacement section shall be a new concrete base, not less than 6 inches thick with HMA base to within 1-1/2 inch of the existing grade and then 1-1/2 inch of HMA surface.
- I. Unless otherwise shown on the drawings, chip and seal pavements shall have 8 inches of Compacted Aggregate, No. 53, Base and 1 inch processed bituminous coated aggregate pavement placed and rolled, in accordance with INDOTSS 404.
- J. Unless otherwise shown on the drawings, aggregate pavement shall be replaced with 12 inches of Compacted Aggregate, No. 53 in accordance with INDOTSS 303.

3.5 HOT MIX ASPHALT (HMA)

- A. This work shall consist of constructing one or more courses of HMA base, intermediate, and wedge leveling or surface mixtures on a prepared foundation in accordance with these specifications and in reasonably close conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.
 - 1. If the required finished depth of any course is to exceed two to four times the top size of the aggregate used as shown by actual screen

analysis, the course shall be constructed in two or more lifts, as directed. Refer to INDOTSS 402 for density requirements.

Mix type shall be as indicated on the drawings, without exception, unless otherwise approved in writing by the WPWD Engineer.

- a. Job mix formulas shall be prepared and submitted for approval in accordance with INDOTSS Section 401. The job mix formula shall include standard bituminous mixture information including, but not limited to, aggregate gradation, binder content, maximum specific gravity, and air voids.
 2. Materials and construction requirements shall comply with the requirements of INDOTSS 401. Acceptance requirements shall be in accordance with INDOTSS 402.
 - B. Place and spread bituminous base mixture with a bituminous paver. In areas inaccessible to a paving machine, place and spread bituminous base mixture by other acceptable mechanical or hand methods.
 - C. Tack coat shall be placed on existing bituminous and/or concrete surfaces before a new lift of bituminous material is added. Apply tack coat uniformly at a minimum rate meeting INDOTSS (0.00025 Tons/SYS).
 1. Patch and clean existing surface. The surface shall be free of irregularities and provide a reasonably smooth and uniform surface to receive the tack coat. Remove and replace unstable corrugated areas with suitable patching materials.
 2. Tack coat shall be placed in accordance with INDOTSS 406.
 - D. Placement and compaction of HMA shall conform to INDOTSS 401.
 - E. Place intermediate or surface used for wedging or leveling, approaches and feathering by mechanical methods or acceptable hand methods for placing and spreading in accordance with INDOTSS 402.
- 3.6 SEAL COAT AND COVERING AGGREGATE (CHIP AND SEAL)
- A. Application shall be per INDOTSS 404.04.
 - B. Seal coat and covering aggregate shall be placed in accordance with INDOTSS Section 404.

3.7 PORTLAND CEMENT CONCRETE PAVEMENT

- A. Portland cement concrete pavement shall consist of a coarse aggregate base (if required) and a reinforced or unreinforced Portland cement concrete surface, as shown on the drawings.
 - 1. Use Compacted Aggregate, No. 53, Base in accordance with INDOTSS 302 for subbase, unless otherwise shown or specified.
 - 2. Pavement cross-section shall be as shown on drawings.
- B. Portland cement concrete pavement operations and materials shall comply with INDOTSS Section 502 unless otherwise specified by the WPWD.
 - 1. Alternate equipment to that specified in INDOTSS Section 502 shall be allowed provided that line, grade, surface, smoothness and other requirements of the specifications are met. The equipment used shall be subject to the approval of a Professional Engineer licensed in the State of Indiana.
 - 2. Expansion and contraction joints shall be installed as indicated on the drawings or as required by INDOTSS 503. Expansion joints shall be required whenever new concrete abuts fixed objects or existing concrete surfaces, whether or not shown on the drawings.
 - 3. Keyway construction, load transfer devices, tie bars and slab and ear reinforcement shall be installed as indicated on the drawings.
 - 4. Unless otherwise shown on the drawings, the final finish of concrete pavement shall be by brooming in accordance with INDOTSS Section 504, to form a transverse skid-resistant finish.
 - 5. The Contractor shall always have materials available to protect the surface of concrete against rain. These materials shall consist of burlap, curing paper or plastic sheeting.
 - 6. New concrete pavement shall be protected by the Contractor until opening to traffic is approved by a Professional Engineer licensed in the State of Indiana. It shall not be opened to traffic until the field-cured concrete has attained a flexural strength of 550 psi, or a compressive strength of 3,500 psi. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Before opening to traffic, the pavement shall be cleaned and permanent lane markings applied to the pavement.

3.8 TESTING FOR HOT MIX ASPHALT (HMA)

- A. At the discretion of the WPWD the Developer/Contractor shall employ and pay for the services of a competent independent testing laboratory to take cores at selected locations and perform described tests.
- B. Compaction requirements for HMA **intermediate** mixtures placed in accordance with INDOTSS Section 401 shall be controlled by in place density determined from cores cut from the compacted pavement in accordance with INDOTSS 402. Cores shall be taken at locations as directed by WPWD Inspector.
 - 1. In lieu of core testing, nuclear density testing is allowable if the surface lift is placed within 24-hours of the intermediate placement.
 - a. Nuclear gauge density testing shall be provided by a third-party testing agency and in accordance with ASTM D7113. Testing personnel shall remain onsite for the entire duration of the paving operation and tests shall be done at a maximum of 15 minutes apart. Reports shall be provided before surface placement can commence to ensure density levels are achieved. These reports can be temporarily handwritten until the final report is received in order to maintain paving schedules.
 - b. If the surface cannot be placed within 24-hours, core testing will be required. There will be no exceptions to this requirement. Weather limitations will not be considered an acceptable exception.
- C. The Contractor along with their independent testing lab representative shall obtain cores in the presence of the WPWD with a device that shall produce a uniform 6 inches in diameter pavement sample. Each HMA course shall be cored within one workday of placement. Damaged core(s) shall be discarded and replaced with a core from a nearby location as selected by the Engineer.
- D. The Contractor, in the presence of the WPWD, shall mark the core to define the course to be tested. If the defined area is less than 1.5 times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing as determined by the Engineer. Within **12-hours** of coring operations the Contractor shall clean, dry, refill and compact the core holes with **the same HMA mix or** suitable material approved by the Engineer.

- E. The Contractor's testing lab representative shall take immediate possession of the cores. If the cores are subsequently damaged, additional coring within the specific section(s) will be required at locations to be determined by the WPWD.
- F. Each core shall be tested within one week of coring operation to determine thickness, bulk specific gravity, aggregate gradation and binder content. Test results shall then be transmitted via email or USPS to both the Contractor and the WPWD for verification before each subsequent bituminous lift is placed.
1. Average thickness of the cores shall not vary from the plan thickness more than 0.5 inch for HMA base and intermediate course(s) and 0.25 inch for HMA surface course(s) for acceptance in accordance with INDOTSS Section 105.
 2. The bulk specific gravity shall be determined in accordance with AASHTO T166 or AASHTO T275. The in place density of a section for a mixture shall be expressed as:
$$\text{Density \%} = (\text{BSG}/\text{MSG}) * 100$$

where:

BSG = bulk specific gravity as determined from independent testing laboratory

MSG = maximum specific gravity as reported on job mix formula.
 3. The calculated density of the cores shall not be less than 92% in accordance with INDOTSS 402. Test results which are outside stated limits shall be considered and adjudicated as a failed material in accordance with INDOTSS Section 105.
- G. The Contractor's independent testing laboratory representative shall determine the aggregate gradation and binder content of the core samples in accordance with ITM 571. Aggregate gradation shall be within tolerances set forth in INDOTSS 401 and binder content shall be within ± 0.5 percent from the job mix formula. Test results which are outside the stated limits shall be considered and adjudicated as a failed material in accordance with INDOTSS Section 105.
- H. A copy of all core test results shall be submitted to the Engineer for verification of specification compliance within one calendar week of core testing.

- I. The Contractor shall make the following tests at their cost and they shall be as specified in this Article and requested by the Engineer. Perform tests in accordance with the following ASTM Specifications:

<u>Test</u>	<u>ASTM Specification</u>
Slump	C143
Air Content	C173
Test Cylinders	C31 or C513
Core Samples	C42
Fly Ash	C311

1. Measure slump each time test beams or cylinders are to be made and at any other time requested by the WPWD. The slump shall be as specified in INDOTSS Section 501, or as otherwise specified herein, unless specifically accepted by the WPWD.
2. Measure air content each time test beams or cylinders are to be made and at any other time requested by the WPWD. The field test may be omitted if the air content is known prior to taking samples. The field test may not be omitted if fly ash is used in the mix.
3. Concrete paving mixes shall comply with guidelines and testing requirements of INDOTSS Section 501. However, in lieu of forming test beams as described in Section 501, the Contractor may substitute cylinder tests as follows:
 - a. Make test cylinders in sets of four. Field cure one cylinder and break at seven days. Laboratory cure the remaining three cylinders and break at 28 days. The Contractor shall be responsible for handling and transportation of cylinders.
 - b. If fly ash is used in the mix, a total set of seven cylinders shall be taken. The additional three cylinders shall be laboratory cured and broken at 56 days, if the 28-day strength does not meet specifications.
 - c. Make one set of test cylinders for each 100 cubic yards, or fraction of 100 cubic yards, of concrete placed; or at other times requested by the WPWD.
 - d. Unless otherwise specified, concrete shall have a 28-day compressive strength of 4,000 psi, as demonstrated by laboratory tests of cylinders.

- B. All HMA Surface lifts shall be nuclear gauge tested by an approved third-party testing agency in accordance with ASTM D7113. Testing personnel shall remain onsite for the entire duration of the paving operation and tests shall be done at a maximum of 15 minutes apart. Final Reports shall be provided within 72-hours of placement of the surface mix.

3.9 PROTECTION

- A. Maintain compacted aggregate subbase and surface true to line and grade and required density. Maintain surface until job is complete.
- B. Do not permit vehicular traffic of any kind on any bituminous course until the bituminous mixture has hardened sufficiently not to be distorted beyond specified tolerances. Remove any foreign material which is on the surface of any course before the course is rolled or any subsequent course is placed.
- C. Do not permit traffic on concrete pavement or sidewalks until concrete has developed sufficient strength not to be marked or damaged. Do not permit vehicular traffic on concrete for at least 14 days.
- D. Repair or replace damaged pavement and sidewalks to the satisfaction of the WPWD or designee.
- E. Any cracking in HMA, at the time of the 3-year Maintenance Bond review period, shall be appropriately crack-sealed in accordance with INDOTSS 408.
- F. Asphalt Tapers shall be installed at all butt joints and shall be constructed a maximum grade of 1:8 (12" long for 1-1/2" depth). These tapers shall be sufficiently compacted and maintained until no more than 2 hours before the permanent lift is installed. Millings shall not be used for these tapers.

3.10 CLEANUP

Clean up the job site following pavement and surfacing restoration. Remove all rubbish, excess materials, temporary structures, and equipment. Leave the work in a neat and presentable condition.

3.11 PAVEMENT MARKINGS

- A. Pavement markings are to be in accordance with all applicable standards of INDOTSS Section 808 and MUTCD, unless otherwise noted in WPWD Specifications, herein.
 - 1. All line markings shall be Paint, unless otherwise approved by WPWD.
 - a. Double-yellow spacing shall be 4" Line, 4" Gap, 4" Line
 - 2. All transverse markings and message markings shall be Thermoplastic, unless otherwise approved by WPWD.
- B. Parking lots are to be striped in accordance with INDOTSS Section 808. Spaces to be striped shall be 4 inch wide stripes.
- C. Contractor shall clean the new pavement surface to remove all dust, dirt, mud and debris prior to striping.
- D. Prior to placement of striping, a final walkthrough with the WPWD Inspector shall be conducted on site.

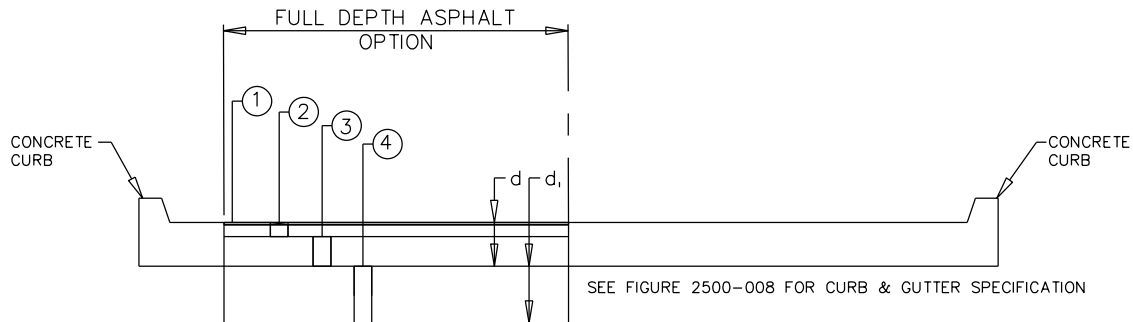
PART 4 - FIGURES

4.1 STANDARD PAVEMENT DETAILS

<u>FIGURE</u>	<u>DESCRIPTION</u>
02500-001	Typical Pavement Section - Local
02500-002	Typical Pavement Section - Collector
02500-003	Typical Pavement Section - Arterial
02500-006	PCCP – Structure Jointing Details
02500-008	Curb Details
02500-009	Underdrain Details
02500-009a	Underdrain Details
02500-010	Sidewalk Details
02500-011	Sidewalk Curb Ramp Notes
02500-012	Cul-de-sac Details
02500-013	Temporary Cul-de-sac Details
02500-014	End of Roadway Details
02500-015a	Street Sign Material Details
02500-015b	Street Name Sign Details
02500-015c	Street Name Sign Details

02500-015d	Regulatory Sign Details
02500-017	Typical Driveway Section
02500-019	Pavement Patching Details
02500-020	Paving Details – New Residential Sections

END OF SECTION 02500



LOCAL STREETS

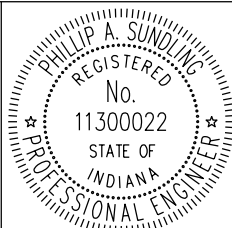
	ASPHALT 1 d=10.5" d _i =14" d+d _i =24.5"	ASPHALT 2 d=10.5" d _i =12" d+d _i =22.5"
1	1.5" SURFACE 9.5 mm	1.5" SURFACE 9.5 mm
2	3" INTERM. 19 mm	3" INTERM. 19 mm
3	6" COMP. AGGR. (SIZE No. 53)	6" COMP. AGGR. (SIZE No. 53)
4	SUBGRADE TRMT. * TYPE IB	SUBGRADE TRMT. TYPE IC

NOTE:

* CHEMICAL MODIFICATION SHALL BE IN ACCORDANCE WITH INDOTSS
215 AND 913.

TYPICAL PAVEMENT SECTION – LOCAL

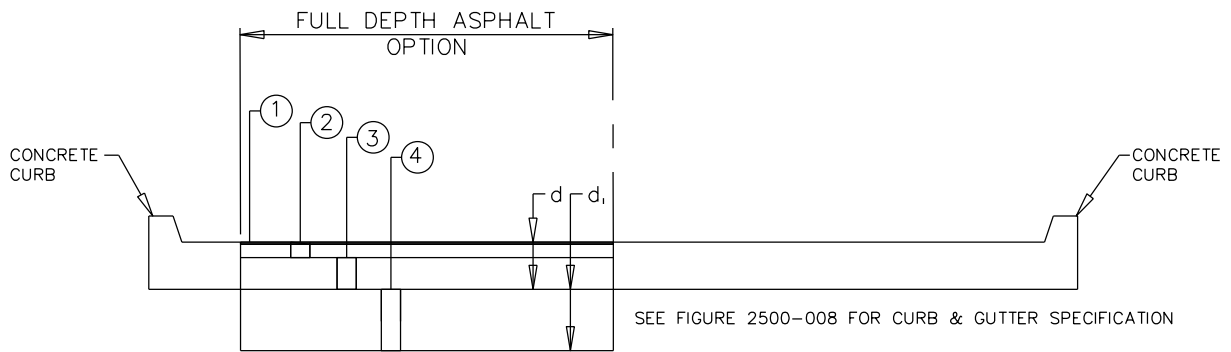
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2/26/16
DATE

FIGURE 2500-001



COLLECTOR STREETS

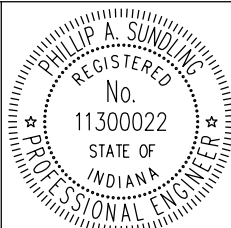
	ASPHALT 1 $d=7.5"$ $d_i=14"$ $d+d_i=21.5"$	ASPHALT 2 $d=12.5"$ $d_i=14"$ $d+d_i=26.5"$
1	1.5" SURFACE 9.5 mm	1.5" SURFACE 9.5 mm
2	2.5" INTERM. 19 mm	2.5" INTERM. 19 mm
3	3.5" BASE 19 mm	2.5" BINDER 19 mm
4	SUBGRADE TRMT. * TYPE IB OR IC	6" COMP. AGGR. (SIZE No. 53)
5		SUBGRADE TRMT. * TYPE IB OR IC

NOTE:

- * CHEMICAL MODIFICATION SHALL BE IN ACCORDANCE WITH INDOTSS 215 AND 913.

TYPICAL PAVEMENT SECTION – COLLECTOR

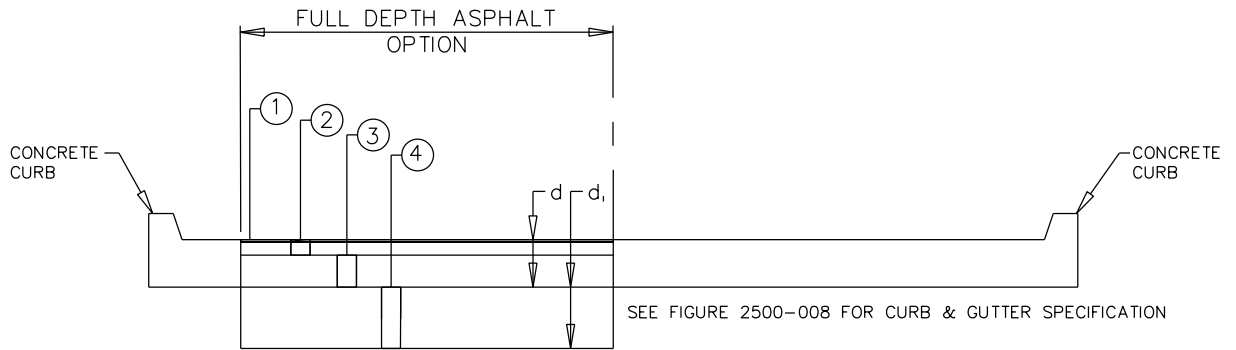
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FIGURE 2500-002



INDUSTRIAL AND ARTERIAL

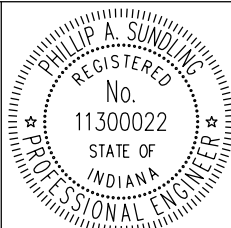
	ASPHALT 1 d=10" d=14" d+d=24"	ASPHALT 2 d=15" d=14" d+d=29"
1	1.5" SURFACE 9.5 mm	1.5" SURFACE 9.5 mm
2	2.5" INTERM. 19 mm	2.5" INTERM. 19 mm
3	2.5" BASE 19 mm	5.0" BASE 25 mm
4	3.5" BASE 19 mm	6" COMP. AGGR. (SIZE No. 53)
5	SUBGRADE TRMT. * TYPE IB OR IC	SUBGRADE TRMT. * TYPE IB OR IC

NOTE:

- * CHEMICAL MODIFICATION SHALL BE IN ACCORDANCE WITH INDOTSS 215 AND 913.

TYPICAL PAVEMENT SECTION – ARTERIAL

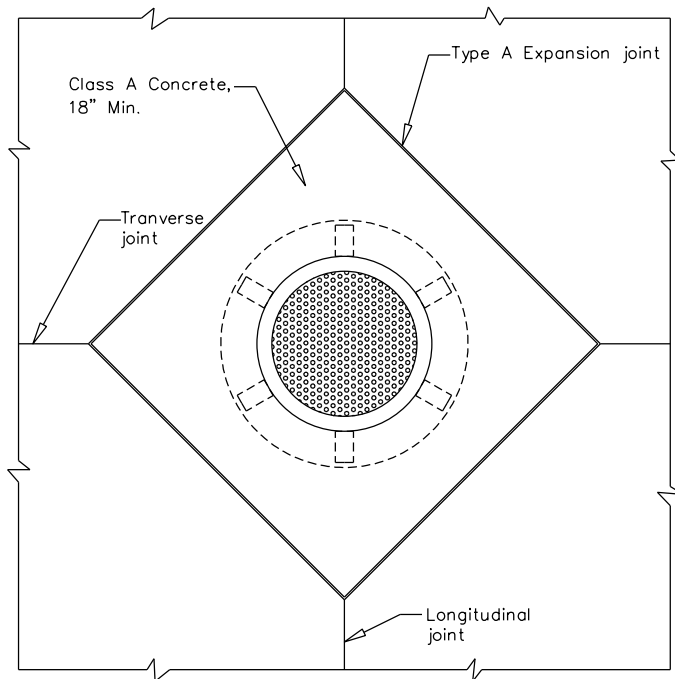
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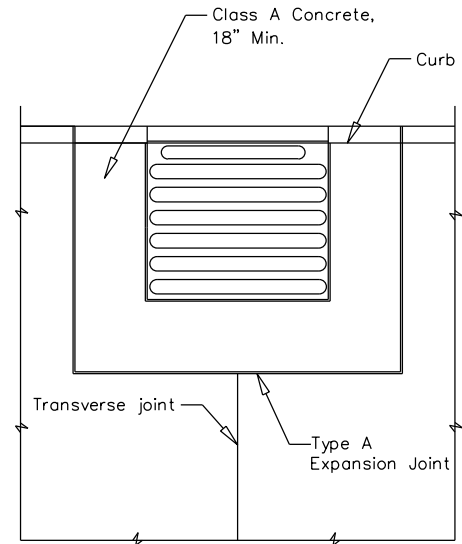
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FIGURE 2500-003



Manhole Boxout



Catch Basin Boxout

1. All catch basins shall be separated from the pavement and curb by boxing out around basin as shown above. Expansion joint material shall extend completely through curb and slab. Manhole castings within the pavement limits shall be boxed in like manner except when telescoping-type castings are used.
2. When a joint falls within 5 ft. of or contacts basins, manholes, or other structures, shorten one or more panels either side of opening to permit joint to fall on round structures and at or between corners of rectangular structures.

PCCP — STRUCTURE JOINTING DETAILS

CITY OF WESTFIELD, INDIANA



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2/26/16
DATE

FIGURE 2500-006



#4 Bar, Smooth,
Epoxy Coated (Typ.)

6"

12"

6"

6"

PINNING DETAIL



#4 Bar, Smooth, Epoxy Coated (Typ.)

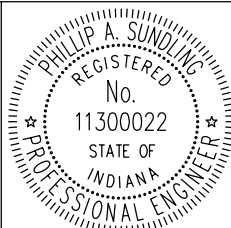
6" 12" 6"

6"

PINNING DETAIL

All New Curb Tying Into Existing Curb Shall Be Pinned
Per Westfield Standard and Specifications 2502.
No Backfilling, Paving, or Compaction Shall Be Done Until
72-Hours After Placement Of The Concrete Curbing.

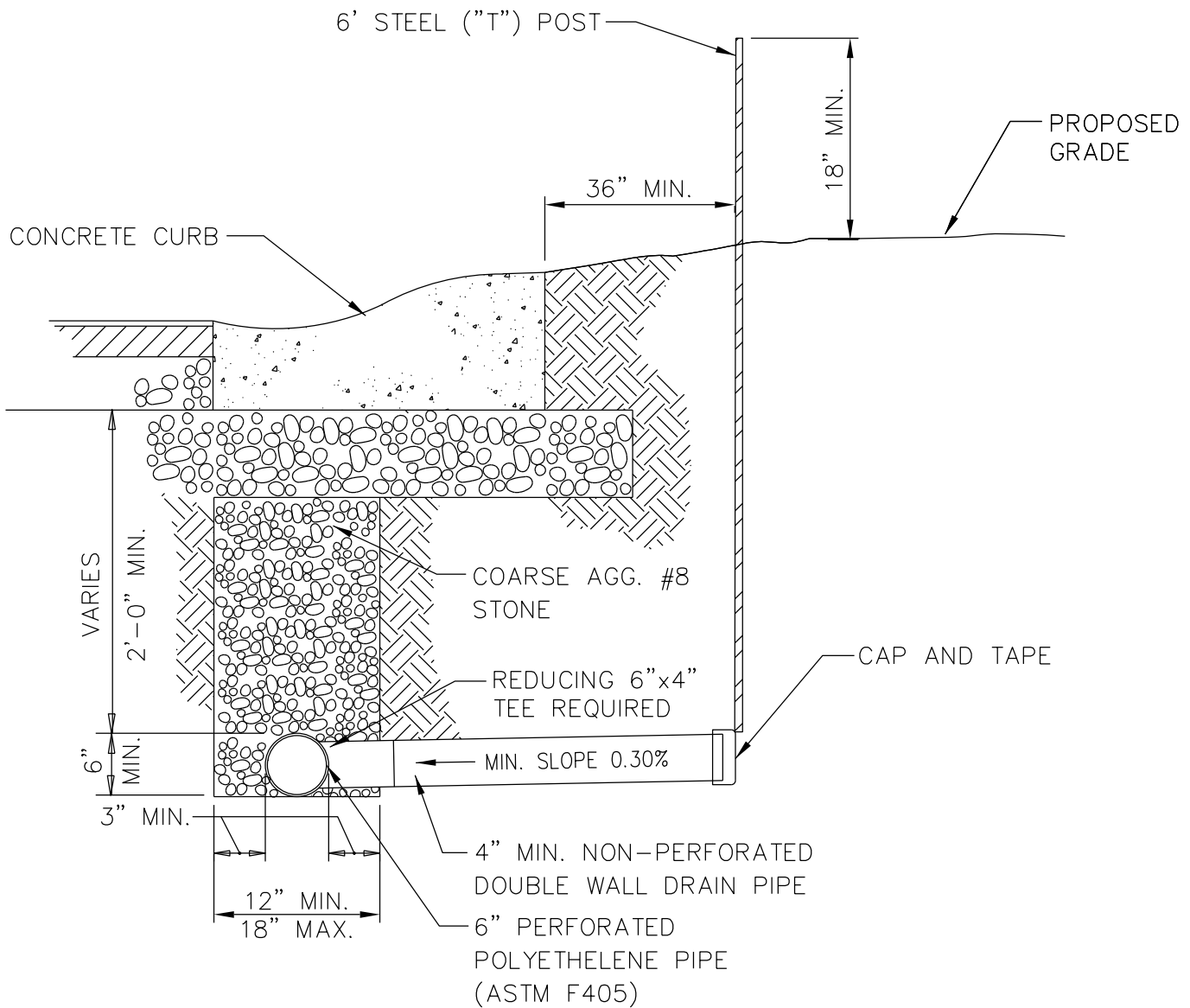
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FIGURE 2500-008

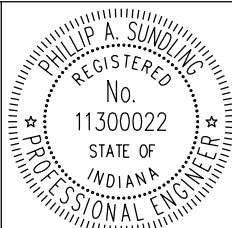


NOTES:

1. LATERAL LOCATIONS SHALL BE STAMPED ON CURB PER WESTFIELD STANDARDS AND SPECS 2502-1.1F
2. MATERIALS AND INSTALLATION IN ACCORDANCE WITH INDOTSS 718.

UNDERDRAIN DETAILS

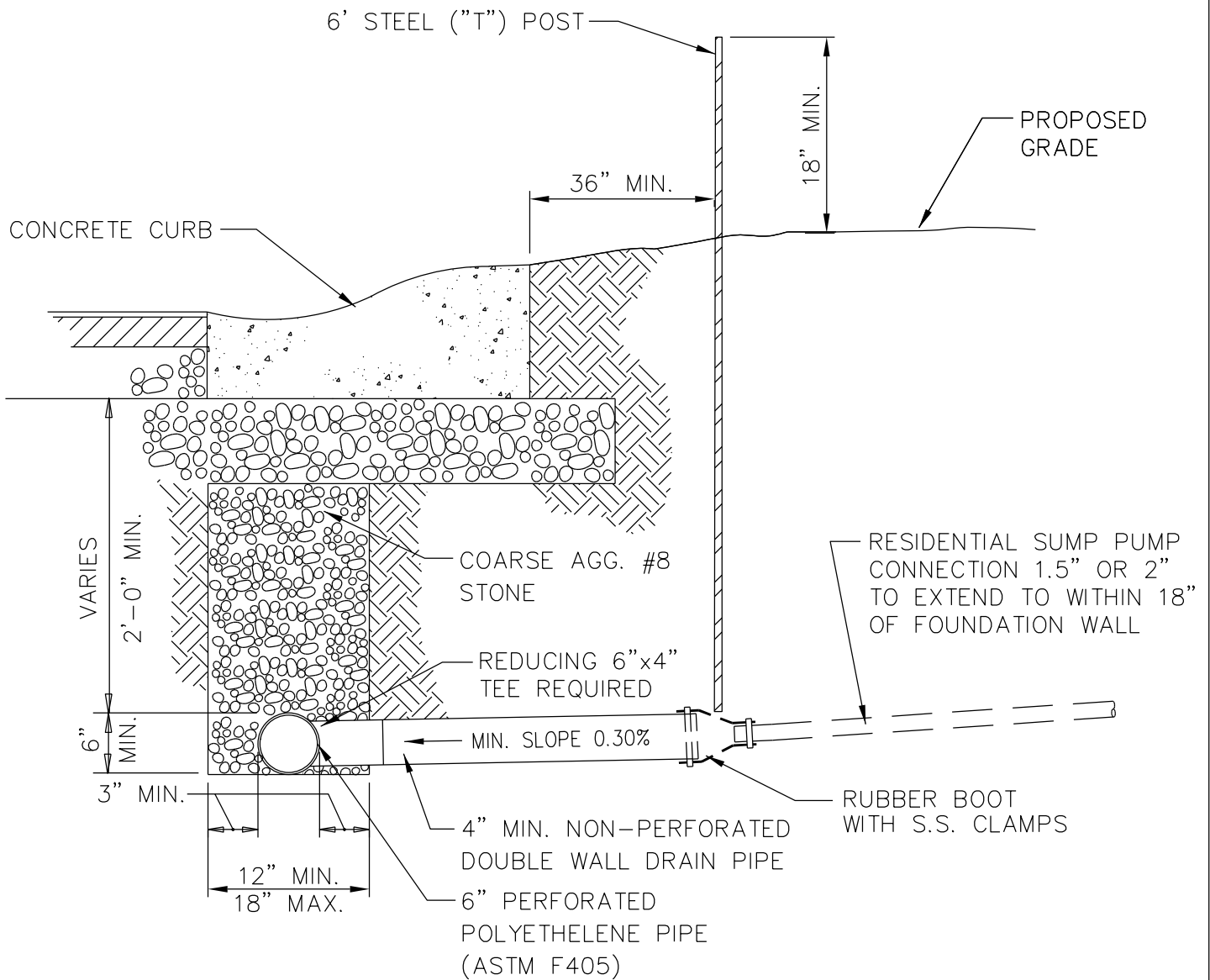
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DATE

FIGURE 2500-009

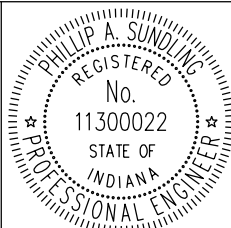


NOTES:

1. LATERAL LOCATIONS SHALL BE STAMPED ON CURB PER WESTFIELD STANDARDS AND SPECS 2502-1.1F
2. MATERIALS AND INSTALLATION IN ACCORDANCE WITH INDOTSS 718.

UNDERDRAIN DETAILS

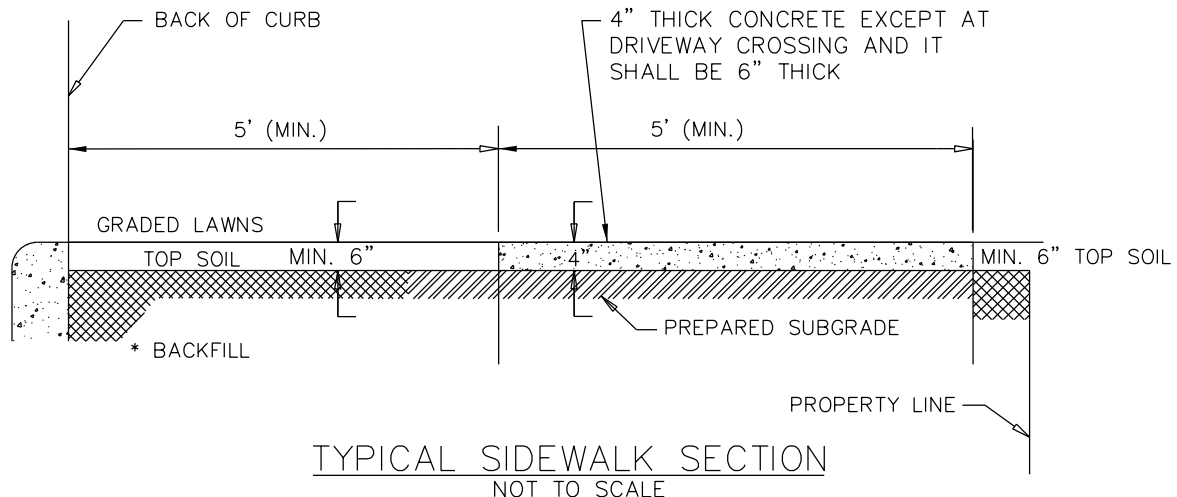
CITY OF WESTFIELD, INDIANA



Phillip A. Sundling

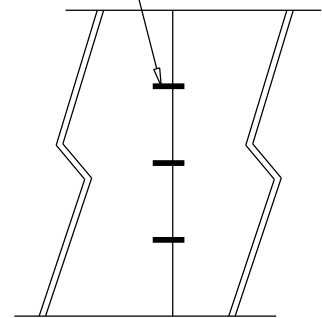
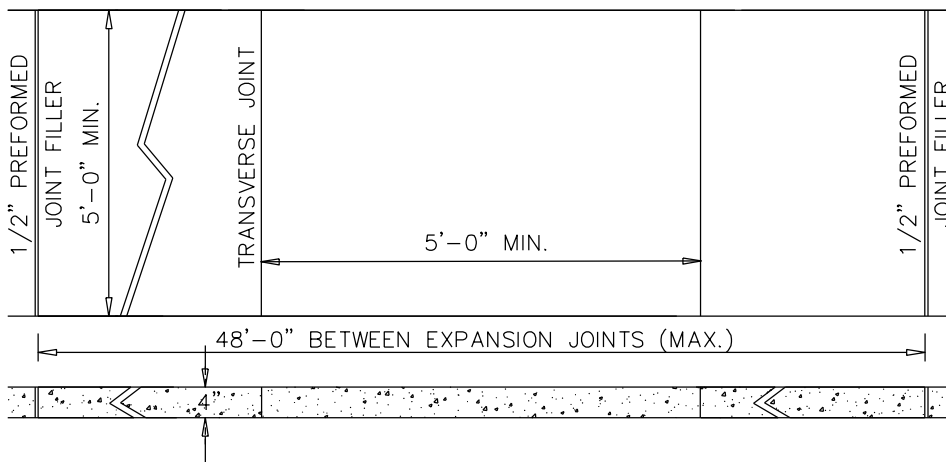
2/26/16
DATE

FIGURE 2500-009a



* THE SPACE BEHIND THE CURB SHALL BE FILLED WITH SUITABLE MATERIAL TO THE REQUIRED ELEVATION AND COMPACTED IN LIFTS NOT TO EXCEED 6" IN DEPTH.

3: #4 BAR, SMOOTH, EPOXY COATED EVENLY SPACED, 12" MIN. FROM EDGE



PINNING DETAIL

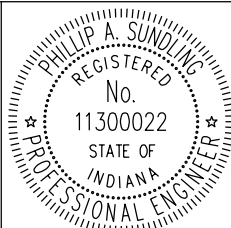
CONCRETE SIDEWALK
NOT TO SCALE

NOTES:

SUBGRADE UNDER ALL CURBS, SIDEWALKS, AND DRIVES SHALL BE COMPACTED IN ACCORDANCE WITH INDOTSS 604. SIDEWALK SHALL BE PINNED AT DRIVEWAYS IN ACCORDANCE WITH WSS 2505.

SIDEWALK DETAILS

CITY OF WESTFIELD, INDIANA



Philip A. Sundling

2/10/17
DATE

FIGURE 2500-010

SIDEWALK CURB RAMP NOTES

THE CITY OF WESTFIELD FOLLOWS THE INDOT GUIDELINES FOR SIDEWALK RAMPS.
THE LIST OF DETAILS BELOW CAN BE FOUND ON THE INDOT WEBSITE:

<http://www.in.gov/dot/div/contracts/standards/drawings/>

See INDOT Std. Dwgs. E 604-SWCR For Additional Details

Curb Ramps Shall NOT Be Permitted Within The Limits Of A Driveway

SIDEWALK CURB RAMP NOTES

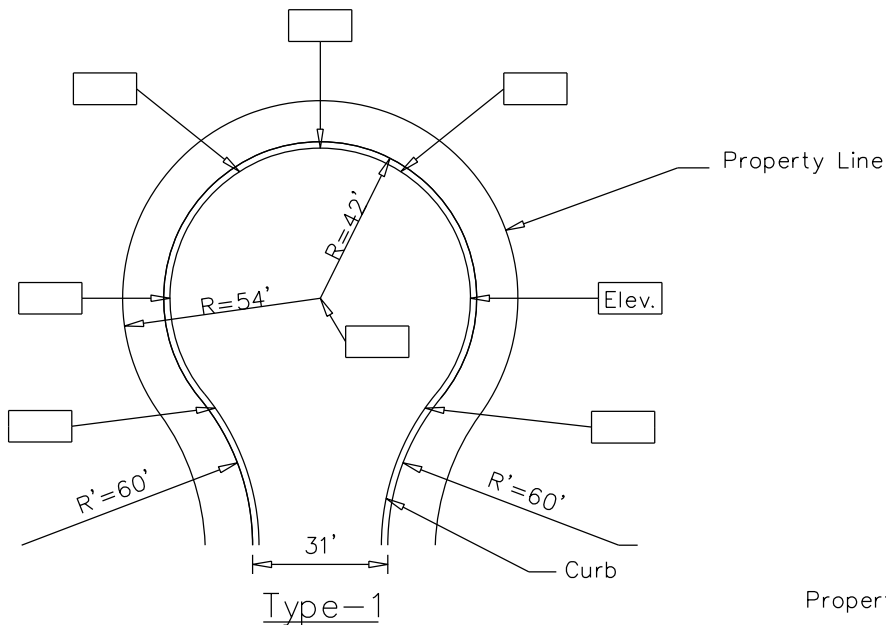
CITY OF WESTFIELD, INDIANA



A handwritten signature in black ink, appearing to read "Philip A. Sundling".

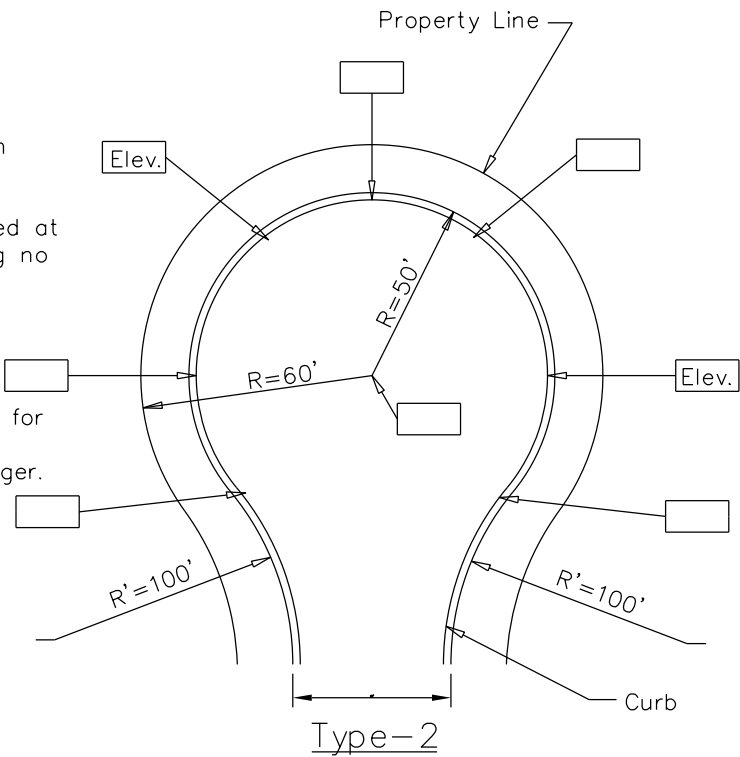
2/26/16
DATE

FIGURE 2500-011



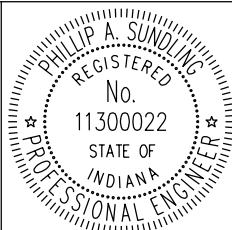
GENERAL NOTES:

1. Type-1 shall be used only in Local subdivisions; all other use Type-2.
2. Warning signs shall be posted at entrance to street, indicating no outlet.
3. Detail shall be identified by street name.
4. Elevations provided shall be proposed flow line of gutter.
5. One detail shall be provided for each cul-de-sac.
6. Scale shall be 1"=40' or larger.
7. Cul-de-sac length shall be a maximum of 600 feet, see section 02501 of the standard specification



CUL-DE-SAC DETAILS

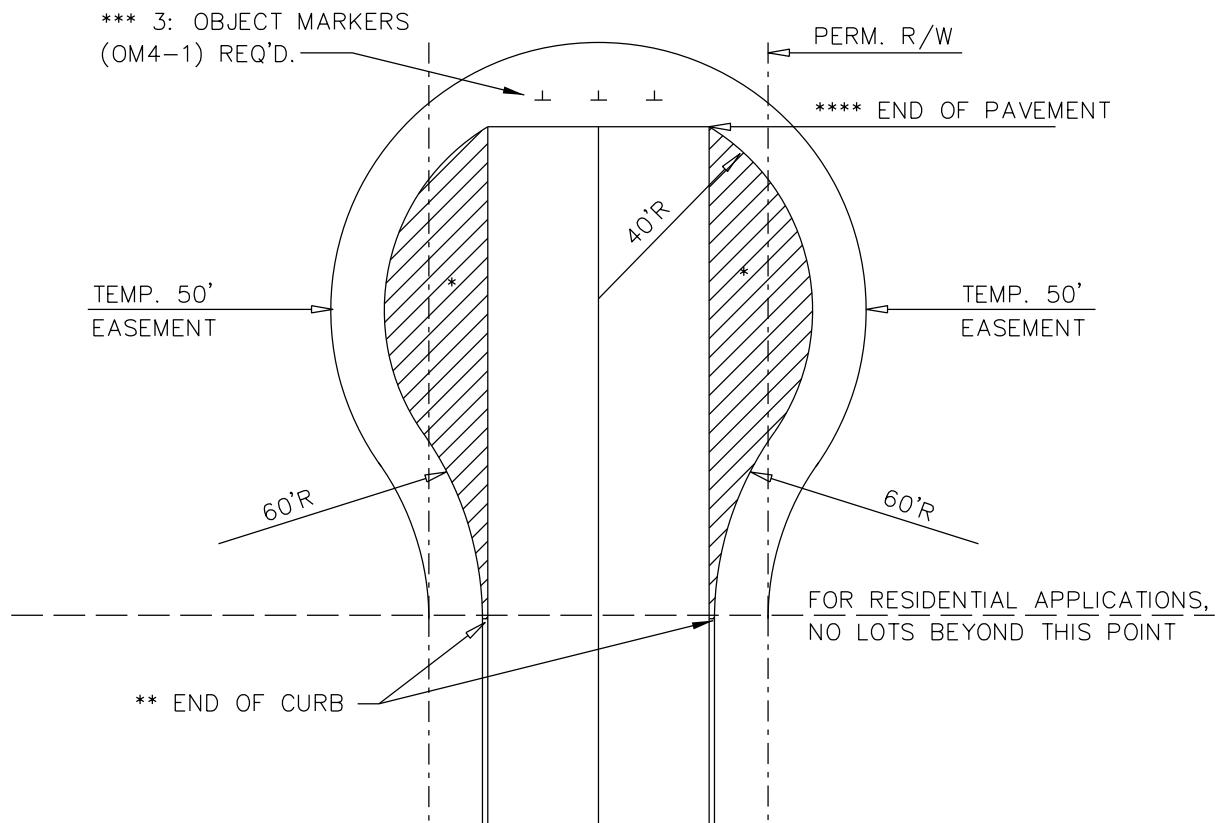
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2/26/16
DATE

FIGURE 2500-012

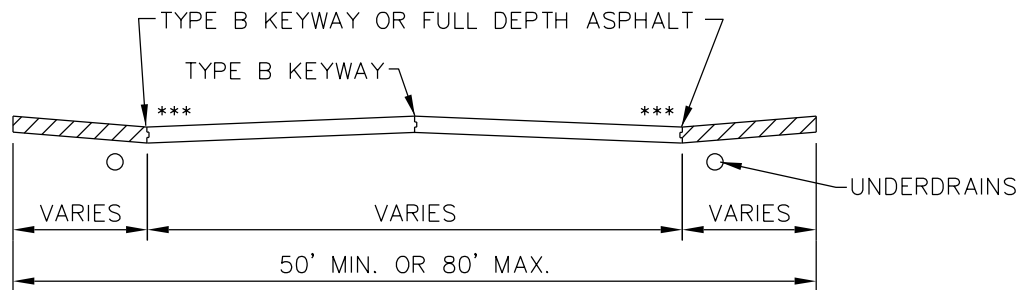


* TO BE REMOVED WHEN THE STREET IS CONTINUED.
THICKNESS AND TYPE TO MATCH PERMANENT PAVEMENT.

** DEVELOPER MAY EXTEND CURB TO END OF PAVEMENT.

*** FOR ADDITIONAL OBJECT MARKER DETAILS, SEE FIGURE 2500-014.

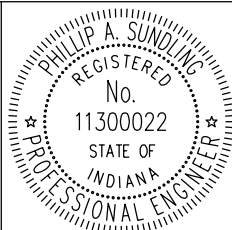
**** UTILITIES SHALL BE EXTENDED TO END OF PERMANENT PAVEMENT LIMITS



NOT TO SCALE

TEMPORARY CUL-DE-SAC DETAILS

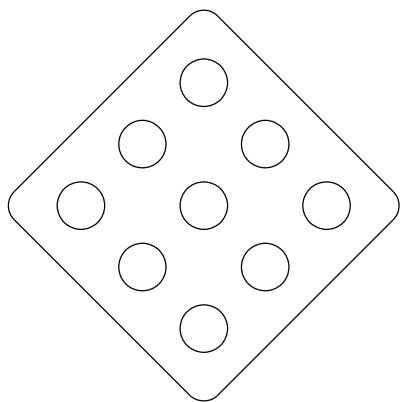
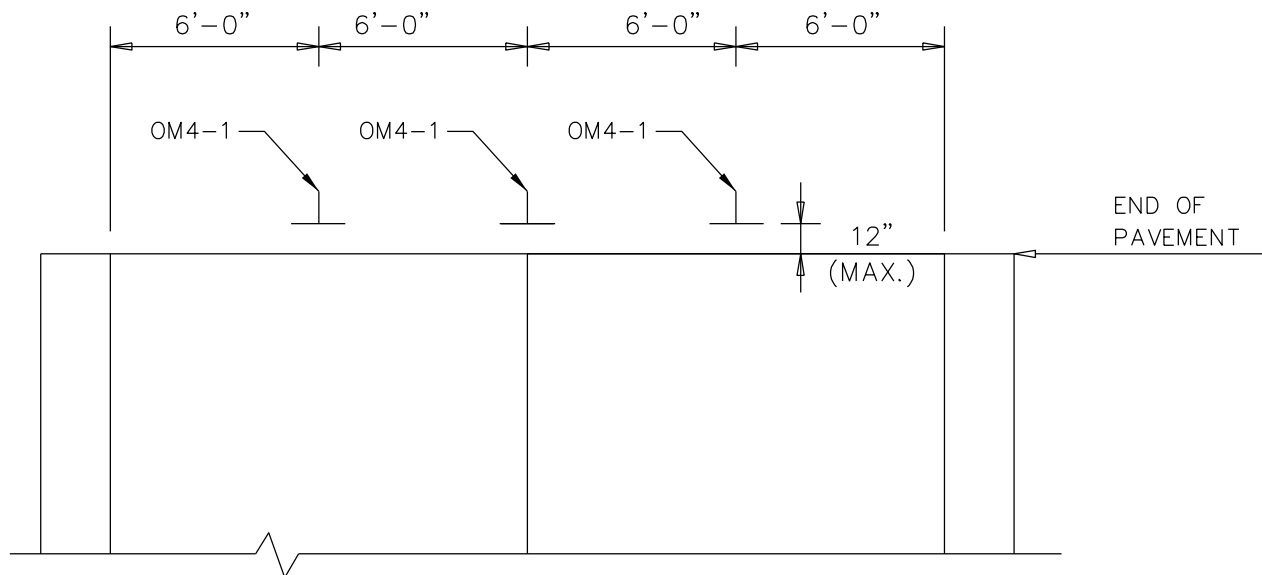
CITY OF WESTFIELD, INDIANA



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FIGURE 2500-013



OBJECT MARKERS (OM4-1)
 SIZE: 18" x 18"
 COLOR: RED ON RED
 MOUNTING HEIGHT: 4'-0" MEASURED FROM
 TOP OF PAVEMENT TO BOTTOM OF SIGN

NOTES:

For Additional Details, See MUTCD, Latest Version, 2C.66.

END OF ROADWAY DETAILS

CITY OF WESTFIELD, INDIANA



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FIGURE 2500-014

High Intensity, Prismatic Reflective Sheeting

INDOT Standard Specifications (2014)
Section 913 Miscellaneous. 919.01 (3a) Traffic signs reflective Sheeting, Encapsulated Lens.

MATERIAL: Traffic Signs fabricated from 3-M (or other INDOT approved) reflective sheeting,
High Intensity, Prismatic ASTM Type IV on aluminum backing

3930 - White (INDOT approval #W088801)
3932 - Red (INDOT approval #W088803)
3935 - Blue (INDOT approval #W088804)
3939 - Brown (INDOT approval #W128801)

3931 - Yellow (INDOT approval #W088802)
3934 - Orange (INDOT approval #W058802)
3937 - Green (INDOT approval #W058805)

Diamond Grade Reflective Sheeting

INDOT Standard Specifications (2014)
Section 919 - Traffic Signs: 919.01 (3a) Traffic signs reflective Sheeting, Encapsulated Lens

MATERIAL: Traffic Signs fabricated from 3-M (or other INDOT approved) reflective sheeting,
Diamond grade ASTM Type IX on aluminum backing

4084 - Fluorescent Orange (INDOT Approval # W068893)
4091 - Yellow (INDOT Approval # W088891)
4095 - Blue (INDOT Approval # W088893)

4090 - White (INDOT Approval # W088890)
4092 - Red (INDOT Approval # W088892)
4096 - Worboy Green (INDOT Approval #W088894)
4097 - Green (INDOT Approval # W088895)

MATERIAL: Traffic Signs fabricated from 3-M reflective sheeting, Diamond grade ASTM Type XI on aluminum backing

4081 - Fluorescent Yellow (INDOT Approval # W088896)
4083 - Fluorescent Yellow/Green (INDOT Approval # W088897)

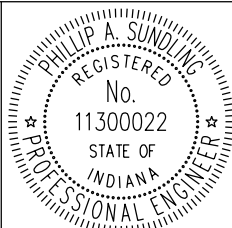
Aluminum Backing Material

INDOT Standard Specifications (2014)
Section 919 - Street Signs: 919.01 (a) Traffic Signs Sheet Signs

GENERAL STREET NAME SIGN NOTES

1. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE FINAL STREET SIGN LEGEND AND BACKGROUND COLOR WITH THE CITY BEFORE ORDERING AND INSTALLING STREET NAME SIGNS.
2. STREET NAME SIGNS WILL MEET THE MINIMUM STANDARDS SPECIFIED IN THE INDIANA MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES AND THE FEDERAL MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES UNLESS OTHERWISE STATED.
3. ALUMINUM BACKING MATERIAL WILL COMPLY WITH INDOT STANDARD SPECIFICATIONS (2014) SECTION 919 - STREET SIGNS: 919.01 (a) TRAFFIC SIGNS SHEET SIGNS.
4. INSTALL GROUND-MOUNTED SIGNS PER STANDARD DWG RD-35 AND OVERHEAD SIGNS PER INDOT STANDARD DWGS.
5. LONGER SIGN LENGTHS WILL REQUIRE SPECIAL SIGN SUPPORTS AND APPROVAL BY THE CITY ENGINEER

STREET SIGNS – MATERIAL DETAILS

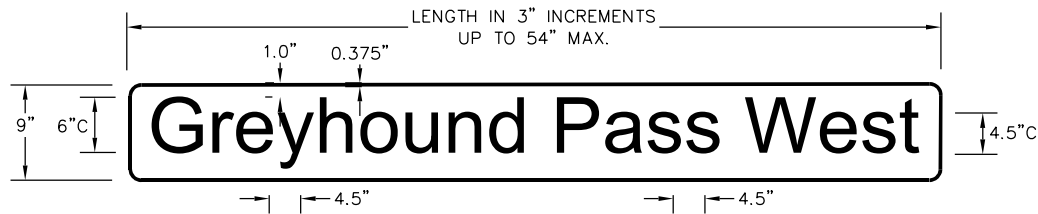


CITY OF WESTFIELD, INDIANA

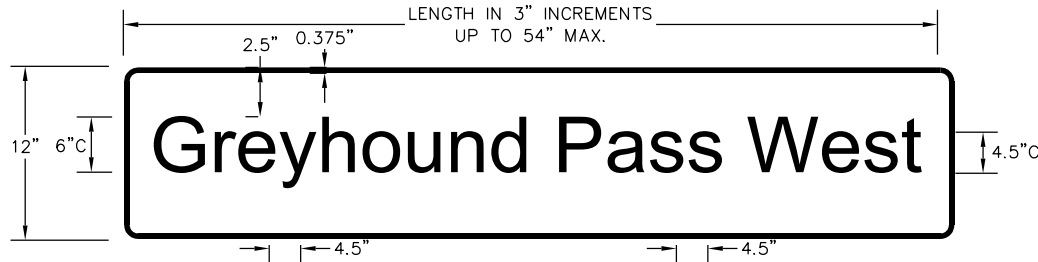
A handwritten signature in black ink, appearing to read "P. Sundling".

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FIGURE 2500-015a



**Subdivisions & Local Roads
with Speeds 25mph or Less**



**Collector and Arterial Streets with
Speeds Greater Than 25mph**

High Intensity, Prismatic Reflective Sheeting

INDOT Standard Specifications (2014)

Section 919 - Traffic Signs: 919.01 (3a) Traffic Signs Reflective Sheeting, Encapsulated Lens.

MATERIAL: Traffic Signs fabricated from 3-M (or other INDOT approved) reflective sheeting,
High Intensity, Prismatic ASTM Type IV on aluminum backing

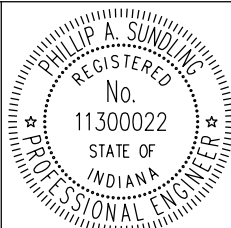
3930 - White (INDOT approval #W088801)
3935 - Blue (INDOT approval #W088804)
3939 - Brown (INDOT approval #W128801)

3932 - Red (INDOT approval #W088803)
3937 - Green (INDOT approval #W058805)

GENERAL STREET NAME SIGN NOTES

1. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE FINAL STREET SIGN LEGEND AND BACKGROUND COLOR WITH THE CITY BEFORE ORDERING AND INSTALLING STREET NAME SIGNS.
2. STREET NAME SIGNS WILL MEET THE MINIMUM STANDARDS SPECIFIED IN THE INDIANA MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES AND THE FEDERAL MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES UNLESS OTHERWISE STATED.
3. ALUMINUM BACKING MATERIAL WILL COMPLY WITH INDOT STANDARD SPECIFICATIONS (2014) SECTION 919 - STREET SIGNS: 919.01 (a) TRAFFIC SIGNS SHEET SIGNS.
4. INSTALL GROUND-MOUNTED SIGNS PER STANDARD DWG RD-35 AND OVERHEAD SIGNS PER INDOT STANDARD DWGS.
5. LONGER SIGN LENGTHS WILL REQUIRE SPECIAL SIGN SUPPORTS AND APPROVAL BY THE CITY ENGINEER

STREET SIGNS – NAME DETAILS

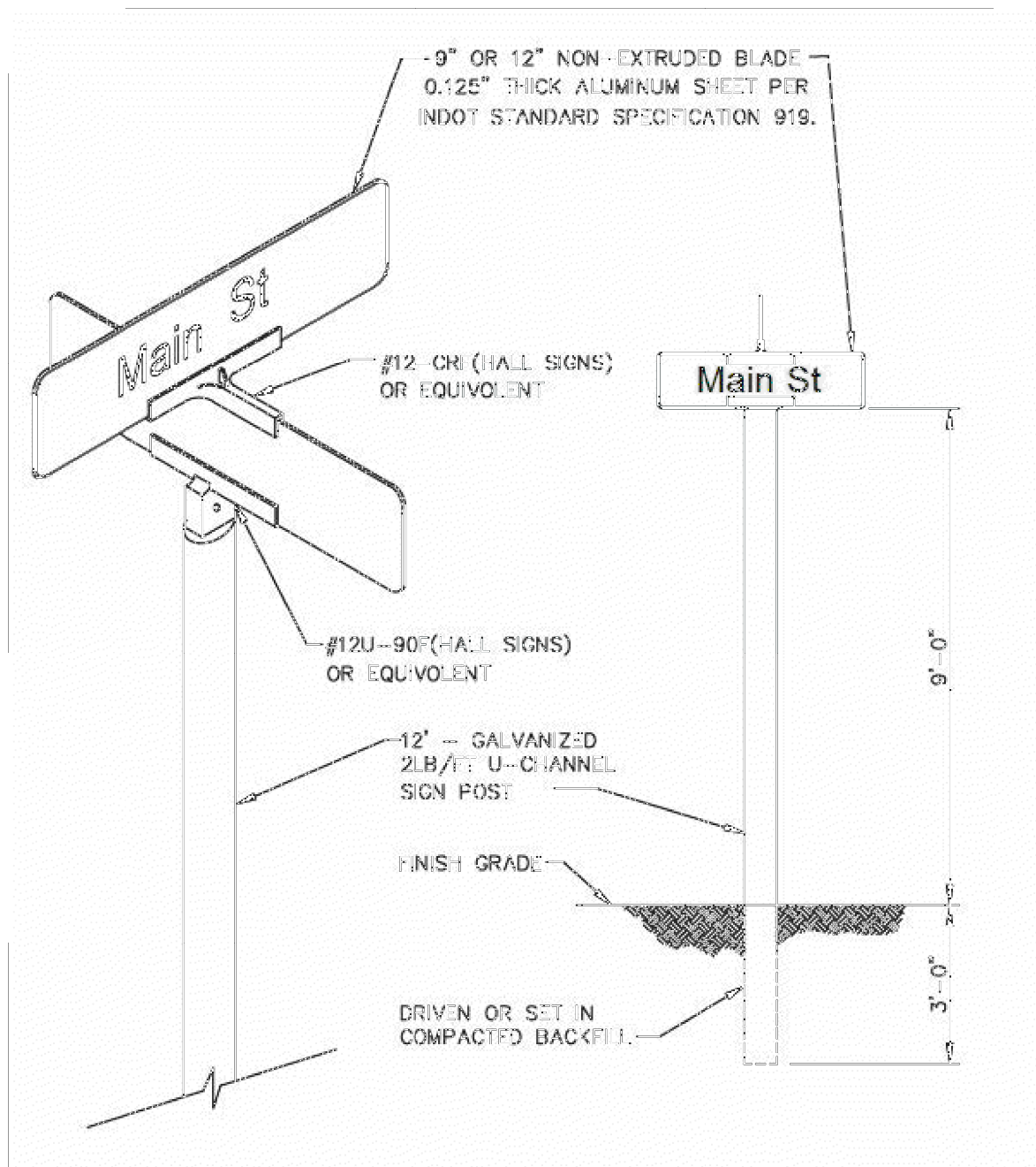


CITY OF WESTFIELD, INDIANA

Phillip A. Sundling

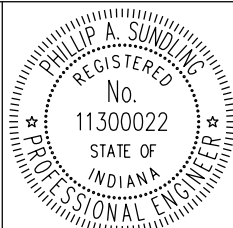
2/26/16
DATE

FIGURE 2500-015b



STREET SIGNS – SIGN DETAILS

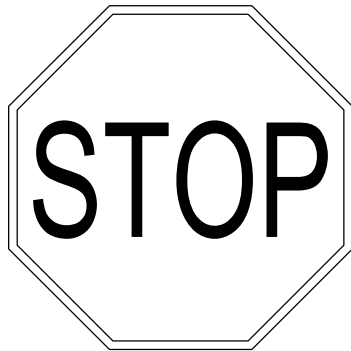
CITY OF WESTFIELD, INDIANA



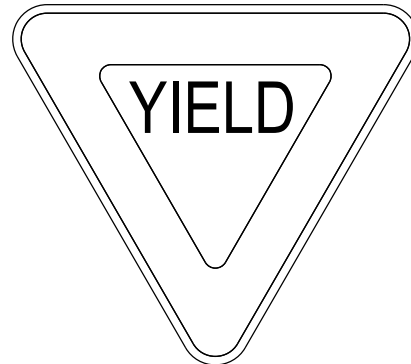
Philip A. Sundling

2/26/16
DATE

FIGURE 2500-015c



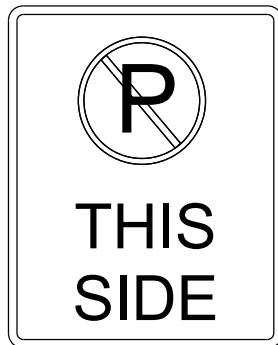
STOP SIGN (R1-1)
30" x 30"



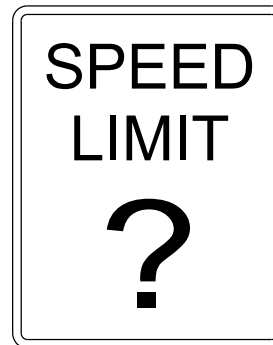
YIELD SIGN (R1-2)
30" x 30" x 30"



R1-4
18" x 6"



NO PARKING SIGN (R7-31)
12" x 18"



SPEED LIMIT SIGN (R2-1)
24" x 30"

NOTES:

- 1.SIGNS SHALL BE SINGLE FACED WITH HIGH INTENSITY REFLECTORIZED SHEETING ON 0.080" THICK ALUMINUM SHEET MATERIAL PER INDOT STANDARD SPECIFICATION 919.
- 2.POSTS SHALL BE 12'-0" LONG, 2lb/ft GALVANIZED U-CHANNEL SIGN POST INDOT STANDARD SPECIFICATION 910.14.
- 3.ALL SIGNS, 36" AND GREATER, SHALL BE; DOUBLE POSTED, 14'-0" LONG, 3lb/ft GALVENIZED U-CHANNEL POST, PER INDOT STANDARD SPECIFICATION 910.14.
- 4.ALL SIGN SIZES, SHAPES, COLORS AND MATERIAL SHALL MEET THE INDIANA MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.

STREET SIGNS – SIGN DETAILS

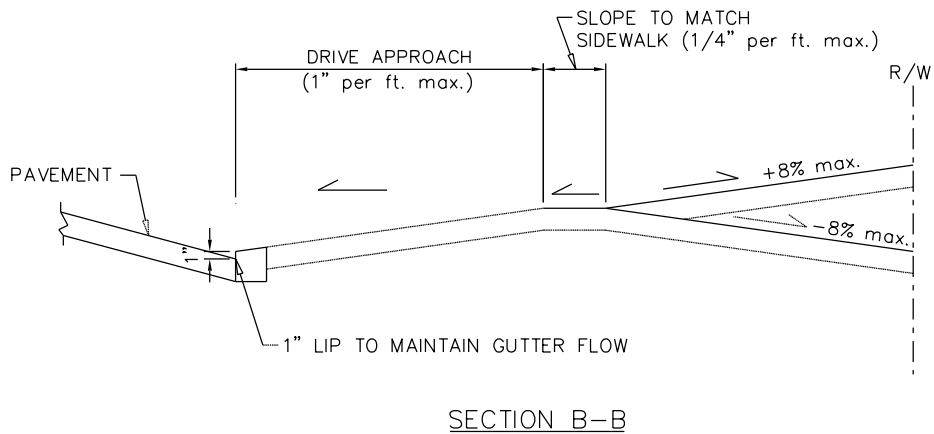
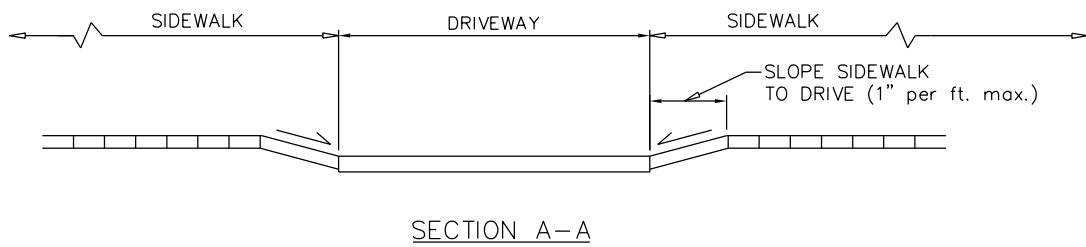
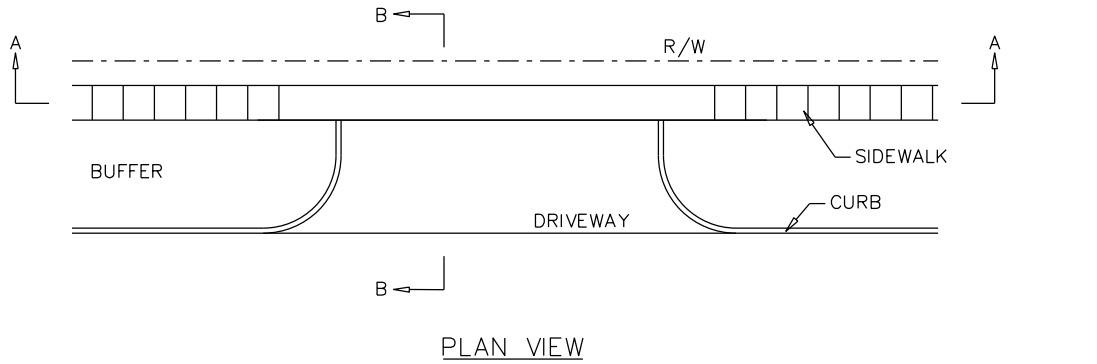


CITY OF WESTFIELD, INDIANA

A handwritten signature in black ink, appearing to read "Phillip A. Sundling".

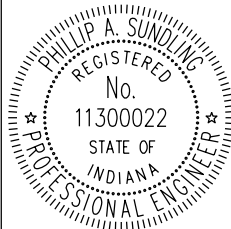
2/26/16
DATE

FIGURE 2500-015d



TYPICAL DRIVEWAY SECTION

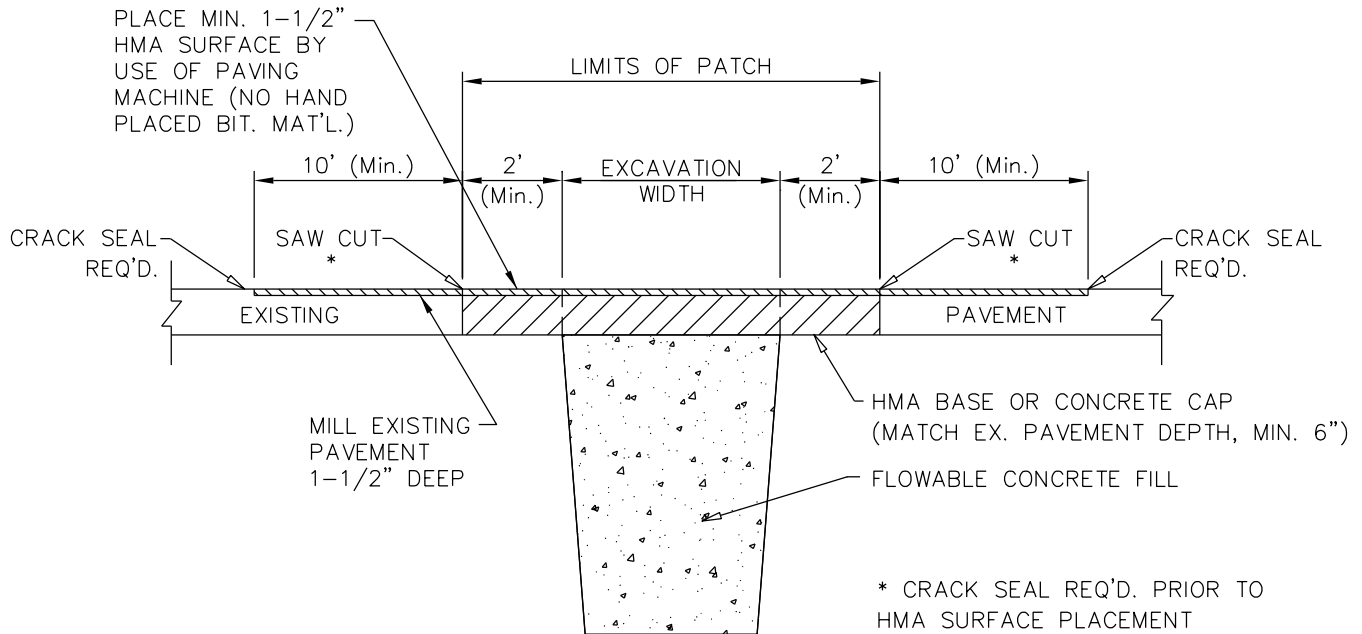
CITY OF WESTFIELD, INDIANA



Phillip A. Sundling

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DATE

FIGURE 2500-017

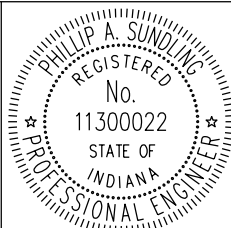


NOTES:

HMA Type To Be Determined By WPWD Engineer.
HMA Base Lift Shall Not Exceed 6".

PAVEMENT PATCHING DETAILS

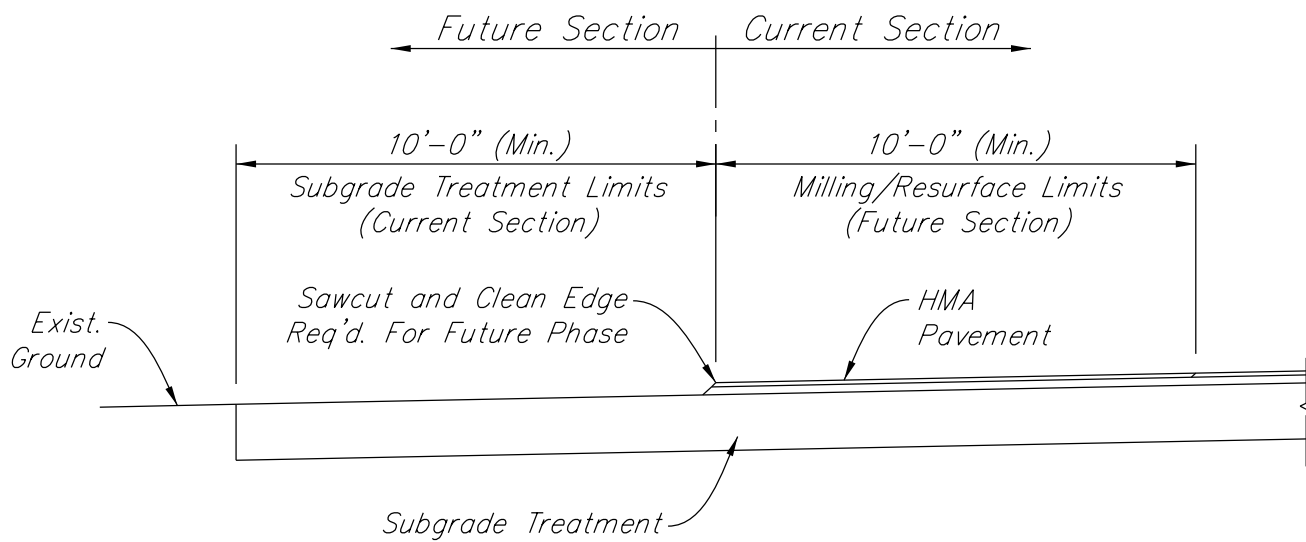
CITY OF WESTFIELD, INDIANA



Phillip A. Sundling

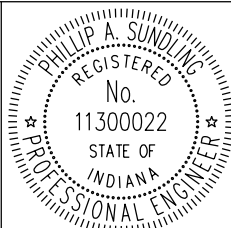
2/26/16
DATE

FIGURE 2500-019



PAVING DETAILS — NEW RESIDENTIAL SECTIONS

CITY OF WESTFIELD, INDIANA



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2/26/16
DATE

FIGURE 2500-020

SECTION 02501 - STANDARDS OF ROADWAY GEOMETRIC DESIGN

PART 1 – GENERAL

- 1.1 The Indiana Design Manual (IDM) in conjunction with the AASHTO Green Book for Geometric Design, latest versions, shall govern if their standards are more stringent than what is outlined and specified below.
- 1.2 Secondary Plats shall conform to the following requirements and standards:
 - A. Minimum Roadway Cross Section Width
 1. Minimum roadway cross section widths, to be installed at the subdivider's expense, shall be as follows:
 - a. Primary Arterials, Per Westfield Thoroughfare Plan generally described as follows: 150 feet of right of way, four (4) lanes at 12 feet, 16 foot center turn lane and/or divided grass landscaped median, plus two (2) feet curb and 6 inch and gutter and two (2) 8 foot asphalt multi-use trails. Reference the most current Westfield Thoroughfare Plan.
 - b. Secondary Arterials, Per Westfield Thoroughfare Plan generally described as follows: 120 feet of right of way, four (4) lanes at 12 feet, or two (2) lanes at 12 feet plus 16 foot center turn lane and/or divided grass landscaped median, plus two (2) feet and 6 inch curb and gutter and two (2) 8 foot asphalt multi-use trails. Reference the most current Westfield Thoroughfare Plan.
 - c. Collector Streets, Per Westfield Thoroughfare Plan generally described as follows: 100 feet of right of way, 36 feet back of curb to back of curb (2 feet and 6 inches curb and gutter) and two (2) 8 foot asphalt multi-use trails. Reference the most current Westfield Thoroughfare Plan.
 - d. Local Streets: 31 feet back of curb to back of curb (2 feet curb and gutter). See Westfield Standard Drawing (WSD) 02501-001.
 - e. Subdivision Streets: Per WSD 02501-001 and 002.
 - f. The pavement of a turning circle at the end of cul-de-sacs shall have a minimum outside diameter of 84 feet for local cul-de-sacs and 100 feet for all others. Cul-de-sacs with an island shall not be permitted.

- g. Frontage Roads: Per WSD 02501-003.
 - h. Alleys: Per WSD 02501-010.
 - i. In all commercial areas, the minimum pavement width shall be 42 feet back of curb to back of curb or as approved by variance by the WPWD Engineer.
 - 2. All streets shall be designed to the standards herein. Inverted crowns shall not be permitted which includes private streets.
 - 3. In all industrial areas, the minimum pavement width (excluding curb and gutter) shall be 24 feet with 8 feet of shoulder on each side of the pavement with "No Parking" on the shoulders.
 - 4. Street trees shall not be within 4 feet of any curb, sidewalk, or trail. All trees and shrubs shall properly match the most current City of Westfield Parks Department Master Tree and Shrub List.
- B. Street Grades, Curves, and Sight Distances
- 1. The minimum vertical grade for all streets shall be 0.5%.
 - 2. Maximum Vertical Grades
 - a. The maximum vertical grade for Primary Arterials and Secondary Arterials shall be 5%.
 - b. The maximum vertical grade for Collectors shall be 8%.
 - c. The maximum vertical grade for Local Roads or Streets shall be 8%.
 - d. The first 25 feet of an intersecting roadway, from the outer edge of a through roadway, shall be designed with a two percent (2%) downward grade. With a sag vertical curve situation, the two percent grade shall connect with the remaining street profile grade using a minimum vertical curve length of 50 feet. This sag vertical curve may start at the edge of the through roadway. With a crest vertical curve at the approach to an intersection, the two percent downward grade shall extend 25 feet from the edge of the through roadway and the crest vertical curve can begin at that point. The length of the crest vertical curve shall meet the requirements of the latest AASHTO Standards for crest vertical curves. Variances from this provision shall require a Spot Elevation Detail to be reviewed and approved by the WPWD Engineer. No standing water will be allowable at

intersections. ADA/PROWAG specifications shall be met at all intersections and other pedestrian crossing areas.

3. Vertical curves shall be designed to meet or exceed the latest AASHTO Standards for sag and crest vertical curves, sight distance, vertical clearance, and any other geometric guideline associated with vertical design.
4. Horizontal alignments shall be designed to meet or exceed the latest AASHTO Standards for curve radii, sight distance, superelevation, tangent length between two radii, and any other geometric guideline associated with horizontal design.
5. All AASHTO Standards shall correspond to the following design speeds:
 - a. Local Roads or Streets shall have a design speed of 25 mph.
 - b. Collectors shall have a minimum design speed of 35 mph. Consult with the WPWD Engineer for further guidance.
 - c. Primary Arterials and Secondary Arterials shall have a minimum design speed of 40 mph. Consult with the WPWD Engineer for further guidance.
6. Each cul-de-sac shall have a terminus of circular shape with minimum right-of way diameter of 108 feet for residential use and 120 feet for industrial use (variance alternative is 2 times the radius for the length of the street). Refer to WSD 02501-012 for additional details.

C. Intersections

1. At street and alley intersections, property line corners shall be rounded by an arc, the minimum radius of which shall be 20 and ten (10) feet respectively. A tangential chord may be substituted for such arc.
2. Street curb intersections shall be rounded by radii of at least 25 feet. A radius of 40 feet shall be used at the intersection with a Primary Arterial, Secondary Arterial or Collector street.
3. The above minimum radii shall be increased when the angle of street intersection is less than 90 degrees. AutoTurn exhibits may be required if a special design vehicle needs to be accommodated at the discretion of the WPWD Engineer.

4. Intersections of more than two (2) streets at one point will not be allowed.
5. Street jogs with centerline offsets of less than 125 feet shall not be permitted.
6. All streets shall intersect at 90 degrees whenever possible for a minimum distance of 100 feet; however, in no instance shall they intersect at less than 80 degrees onto Primary Arterials, Secondary Arterials, or Collectors; or at less than 70 degrees onto Local Roads or Streets.
7. The following paragraphs shall be required as provisions of restrictive covenants of all Secondary Plats to which they apply:
 - a. No fence, wall, hedge, tree or shrub planting which obstructs sight lines and elevations between three (3) and nine (9) feet above the street shall be placed or permitted to remain on any corner lot within the triangular area formed by the street right-of-way lines and a line connecting points 40 feet from the intersection of said street lines 40 feet for Collectors and Local Roads and Streets; and 75 feet for Primary Arterials and Secondary Arterials, or in the case of a rounded property corner, from the intersection of the street right-of-way lines extended.
 - b. The same sight line limitations shall apply to any lot within ten (10) feet of the intersection of a street right-of-way line with the edge of the driveway pavement or alley line. No driveway shall be located within 75 feet of the intersection of two streets, unless otherwise approved in writing by the WPWD Engineer.
8. At the intersection of any proposed Subdivision Road, Local Road, Street or Drive with a Primary Arterial, Secondary Arterial, or Collector, acceleration and deceleration lanes, passing blisters or left turn lanes shall be provided on the Primary Arterial, Secondary Arterial, or Collector. Reference Figure 02501-013.
9. The design of roundabouts shall follow the manual below:
 - a. Federal Highway Administration NCHRP Report 672 “Roundabouts: An Information Guide” Second Edition Indiana Design Manual or most current edition.

D. Easements

1. Where alleys are not provided, easements for utilities shall be provided. Such easements shall have minimum widths of 20 feet, and where located along lot lines, one-half the width shall be taken from each lot.
2. Where a subdivision is traversed by a watercourse, drainage ditch, channel, or stream, adequate areas for storm water or drainage easements shall be allocated for the purpose of widening, deepening, sloping, improving or protecting said watercourses in accordance with the requirements of the Hamilton County Drainage Board, WPWD, and other governing bodies that have jurisdiction over these water courses.
3. The Subdivider shall be encouraged to design for the placement of utility lines underground, following the required standards and specifications established by each utility company. The location of each underground utility system shall be shown by appropriate easement lines on the proposed plat.

E. Obstruction Free Zones

The obstruction free zone is defined as the roadside area next to the travel way which shall be free from hazards and obstructions. Obstacles within the obstruction free zone limits shall be removed, made breakaway, or shielded with guardrail. The obstruction free zone values given below are minimums and shall be extended where accident experience indicates a wider zone would further enhance safety. The following obstruction free zones apply to roadway projects:

1. Rural and Urban Arterials with Shoulders. Where the design speed is 50 mph or greater and the design ADT is over 1500, the minimum obstruction free zone is 20 ft from the edge of the through traffic lanes or to the right-of-way line, whichever is less. For roadways where the design speed is less than 50 mph, and the design ADT is less than 1500, the minimum obstruction free zone from the edge of through traffic lanes is 10 ft plus the usable shoulder width provided, or to the right-of-way line, whichever is less.
2. Rural and Urban Collectors with Shoulders. Where the design speed is 50 mph or greater and the design ADT is over 1500, the minimum obstruction free zone from the edge of the through traffic lanes is 10 ft plus the usable shoulder width provided, or to the right-of-way line, whichever is less. For Roadways where the design speed is less than 50 mph and design ADT is less than 1500, the minimum obstruction free

zone from the edge of through traffic lanes is 6.5 ft, plus the usable shoulder width provided, or to the right-of-way line, whichever is less.

3. Rural and Urban Local Roads and Streets with Shoulders. The minimum obstruction free zone from the edge of the through traffic lane is 6.5 ft plus the usable shoulder width provided, or to the right-of-way line, whichever is less.
4. Curbed Roadways. Where curbs are 6 in. or higher and the posted speed limit is less than 50 mph, the minimum obstruction free zone from the face of the curb shall be 1.6 ft. However, for traffic signal supports the minimum obstruction free zone shall be 2.6 ft. Where the curbs are less than 6 in. in height or the posted speed limit is 50 mph or greater regardless of curb height, the minimum obstruction free zone will be the same as defined in Items A, B, or C above.
5. Appurtenance-Free Area. Roadways for all functional classifications shall have a 1.6 ft appurtenance-free area from the face of curb or from the edge of the travel lane if there is no curb. For traffic signal supports, a 2.6 ft clearance shall be provided. The appurtenance free area is defined as a space in which nothing, including breakaway safety appurtenances, shall protrude above the paved or earth surface. The objective is to provide a clear area adjacent to the roadway in which nothing will interfere with extended side-mirrors on trucks, with the opening of vehicular doors, etc.
6. On-Street Parking. The following obstruction-free zone requirements will apply to facilities with on-street parking.
 - a. Continuous 24-Hour Parking. No obstruction-free zone is required on facilities where there is continuous 24-hour parking, except that the appurtenance-free area as shown in Figure 55-5A shall be provided from the face of the curb or edge of the parking lane if there is no curb.
 - b. Parking Lane Used as a Travel Lane. The obstruction-free zone shall be determined assuming the edge of the parking lane as the right edge of the farthest right travel lane.
7. The designer shall eliminate or modify the following hazards, according to the above treatments, if they are within the obstruction free zone:

- a. Tree Removal. Trees that will mature to a diameter of 4 in. or more shall be removed from the obstruction free zone, unless shielded by a protective device required for other purposes. Trees on back slopes may generally remain if they are unlikely to be impacted by errant vehicles.
- b. Obstructions. Obstructions within the obstruction free zone, such as rough rock cuts, boulders, headwalls, foundations, etc., with projections that extend more than 4 in. above the ground line shall be removed, relocated, made breakaway or shielded with guardrail as appropriate. A rough rock cut is one that presents a potential vehicular snagging problem.
- c. Sign and Light Supports. Sign posts and light poles to remain within the obstruction free zone will be made breakaway. In urban areas where pedestrian traffic is prevalent, breakaway light supports shall not be used. However, these supports should, as a minimum, be offset beyond the obstruction free zone value as presented in Section 02501 – 1.1 – E or desirably behind the sidewalk. In other areas where pedestrian traffic is prevalent, the use of breakaway supports will be considered on a case-by-case basis by the field review team.
- d. Traffic Signals. Traffic signal supports shall be placed to provide the obstruction-free zone through the area where the traffic signal supports are located. However, the following exceptions will apply:
 - i. Channelized Islands. Installation of signal supports in channelizing islands shall be avoided, if practical, however, if a signal support must be located in a channelizing island, a minimum clearance of 30 ft shall be provided from all travel lanes (including turn lanes) in rural areas and in urban areas where the posted speed is greater than 45 mph. In urban areas where the island is bordered by a barrier curb and the posted speed is 45 mph or less, a minimum clearance of 10 ft shall be provided from all travel lanes (including turn lanes).
 - ii. Non-Curbed Facilities (Posted Speeds \geq 50 mph and ADT > 1500). Where conflicts exist such

that the placement of the signal supports outside of the obstruction-free zone is impractical (e.g., conflicts with buried or utility cables), the signal supports shall be located at least 10 ft beyond the outside edge of the shoulder.

- iii. Non-Curbed Facilities (Posted Speeds < 50 mph or ADT \leq 1500). Where conflicts exist such that the placement of the signal supports outside of the obstruction-free zone is impractical (e.g., conflicts with buried or utility cables), the signal supports shall be located at least 6.5 ft beyond the outside edge of the shoulder.
- e. Culverts. Culvert ends are considered to be within the obstruction free zone if the point at which the top of the culvert protrudes from the slope is within the obstruction free zone. Transverse Slopes on Side Roads and Private Drives. Steep transverse slopes on side roads and private entrances shall be considered for flattening, if practical. Desirably these slopes shall be 6:1 or flatter, but in no case shall they be steeper than 4:1. Transverse slopes on median crossovers will be 10:1 or flatter.
- f. Curbs. Curbs shall generally be removed on rural highways where posted speeds are greater than 45 mph. The proper placement of traffic control devices must be considered in reviewing the removal of corner island curbs where such devices are located. This item is not intended to cover divisional (channelizing) islands separating two-way traffic or curbs at the edge of shoulder for drainage. In the latter two cases, sloping curbs shall be used on highways with posted speeds greater than 45 mph. Curbs higher than 4 in. shall not be used in conjunction with guardrail. The face of curbs, used in conjunction with guardrail, shall desirably be behind the face of the rail. If this cannot be achieved, the face of the curb may be located flush with the face of the rail.
- g. Utility Poles. Utility poles within the obstruction free zone which are not owned by the City of Westfield or INDOT often constitute a significant hazard and shall be removed or relocated outside of the proposed right of way as to not interfere with any proposed or existing sidewalk or trail. Additional easements for utility poles outside of the right of way may be required by the

utility company. Utility companies shall be requested to relocate utility poles that are located in high vulnerability areas such as channelizing islands, or where the accident history indicates there has been a utility pole accident problem. The WPWD, based on their judgment, will determine where such work is warranted.

- h. Utility Pedestals. Existing utility pedestals shall be removed or relocated outside of the proposed right of way as to not interfere with any other utilities. New utility pedestals shall be placed outside of the proposed right of way and shall be installed as to not interfere with any other utilities.
- i. Non-Traversable Hazards. Fill slopes steeper than 1:1 with a height greater than 2 ft within the obstruction-free zone shall be flattened to the extent practical. If any part of a drainage ditch appears within the obstruction-free zone, it shall be relocated.

F. Roadside Safety

- a. All new guardrail placed within the City of Westfield shall be timber per WSD 2501-017. See specifications below:
 - i. All timber shall be AWP copper naphthenate treated as per current state and/or AASHTO specifications.
 - ii. All timber to be graded as per NFPA 1991 National Design Specifications for Wood Construction.
 - iii. Rail posts to be douglas fir-larch, No. 1, Post & Timber.
 - iv. 4" x 10" & 4" x 4" railing to be douglas fir-larch, No. 1 SIS.
 - v. Balance of timber to be douglas fir-larch, in accordance with design requirements.
 - vi. All timber is rough unless otherwise noted.
 - vii. All timber cut or drilled in field shall be treated with an approved preservative.
 - viii. All hardware to meet ASTM A307-97 and all structural steel to meet ASTM A36, except as noted. All to be galvanized as per current state specifications and/or AASHTO material specifications.
 - ix. Construction requirements shall conform to INDOT state standards.
 - x. All timber to be cut to exact length, dressed to size required, and all practical framing to be done prior to treatment.

b. Construction requirements:

- i. All holes drilled in field where spikes are used are to be 1/16" smaller than spike size.
- ii. Holes drilled for bolts are to be 1/16" larger than bolt size.
- iii. Holes drilled for ¾" lag bolts are to be 9/16" in diameter for the threaded portion of the bolt and 13/16" for the shank portion.
- iv. Any nut or machine bolt head in direct contact with the timber shall have one plate washer between nut & timber, or bolt head & timber.
- v. Any nut or machine bolt head in direct contact with the steel shall have one cut washer between nut & steel, or bolt head & steel.
- vi. Set threads on all bolts at nut with a center punch after tightening.

c. For additional design details regarding roadside safety measures, refer to Indiana Design Manual Chapter 49.

G. Bridges

- a. The design of vehicular bridges shall follow the manual below:
 - i. AASHTO LRFD Bridge Design Specifications 6th Edition with 2013 Interim Revisions or most current edition.
 - ii. The design of pedestrian bridges shall follow the manuals below:
 1. AASHTO LRFD Guide Specification for the Design of Pedestrian Bridges 2nd Edition or most current edition.
 2. AASHTO Guide for the Development of Bicycle Facilities Fourth Edition or most current edition.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

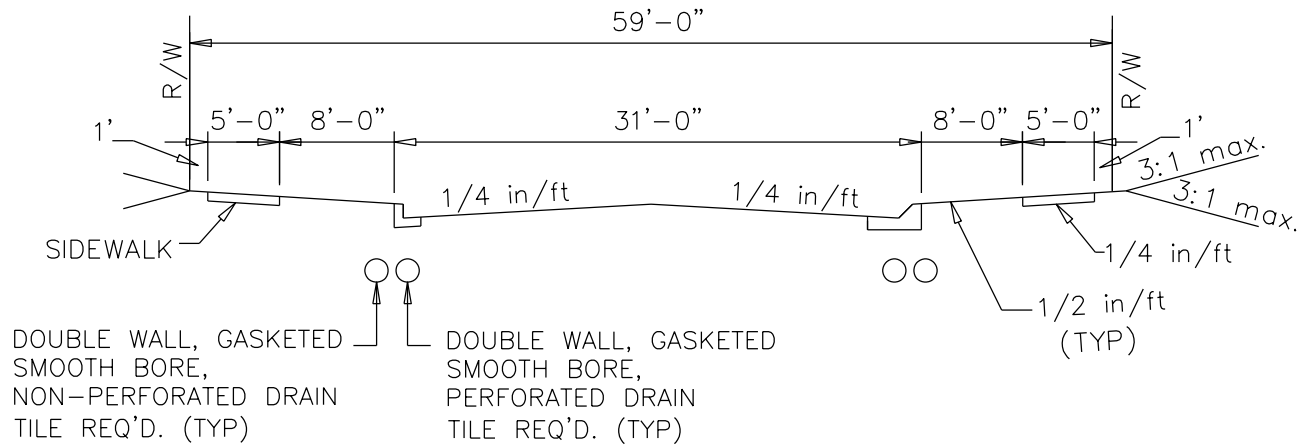
Not Applicable

PART 4 – FIGURES

4.1 STANDARD GENERAL DETAILS

<u>FIGURE</u>	<u>DESCRIPTION</u>
02501-001	Typical Cross Section – Local Street
02501-003	Typical Cross Section – Frontage Road
02501-010	Typical Cross Section – Local Alley
02501-013	Minimum Subdivision and Commercial Entrance
02501-015	Residential Driveway
02501-016	Sight Triangle Details
02501-017	Timber Guardrail Details

END OF SECTION 02501



TYPICAL SECTION - LOCAL STREET

- NOTES:
1. The curb & gutter shall be Type I or Type II as shown on the Curb & Gutter standard sheets. Type II curb & gutter shall be used adjacent to, and in, non-residential or multi-family residential areas and on entrances of residential development along thoroughfares.
 2. For curb and gutter detail, see Figure 2500-008
 3. 8'-0" tree buffers are required for all local streets. Refer to the City of Westfield street tree planting specifications for additional details. For approved species, see Master Tree List.

TYPICAL CROSS SECTION: LOCAL STREET

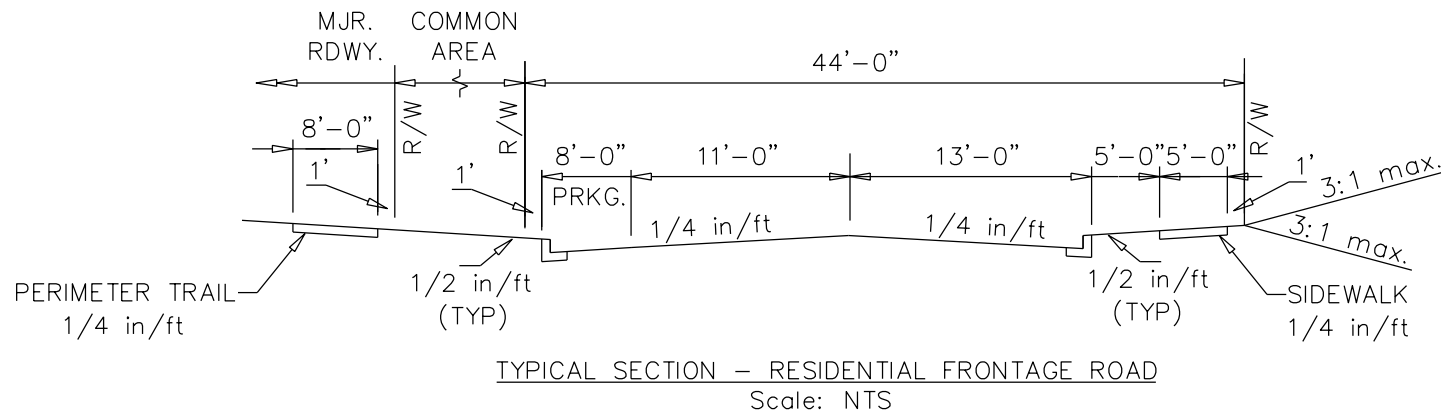


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FIGURE 2501-001



- NOTES:
1. The curb & gutter shall be Type I or Type II as shown on the Curb & Gutter standard sheets. Type II curb & gutter shall be used adjacent to, and in, non-residential or multi-family residential areas and on entrances of residential development along thoroughfares.
 2. For curb and gutter detail, see Figure 2500-008. For perimeter trail detail, see Figure 2505-001
 3. Refer to the current Westfield Thoroughfare Plan Section 5.1 for the typical cross sections for Collector, Secondary Arterial, and Primary Arterial.
 4. For residential applications, see Figure 2500-001 for pavement section details. For mixed-use or commercial applications, see Figure 2500-002 for pavement section details.
 5. For street tree applications, buffers should be widened to 10'-0". Add'l R/W Req'd. For two-sided on-street parking applications, back-of-curb to back-of-curb width shall be widened to 38'-0". Add'l R/W Req'd.
 6. Common Area width varies depending on landscaping plan, utilities, and other incidentals. 10' min.

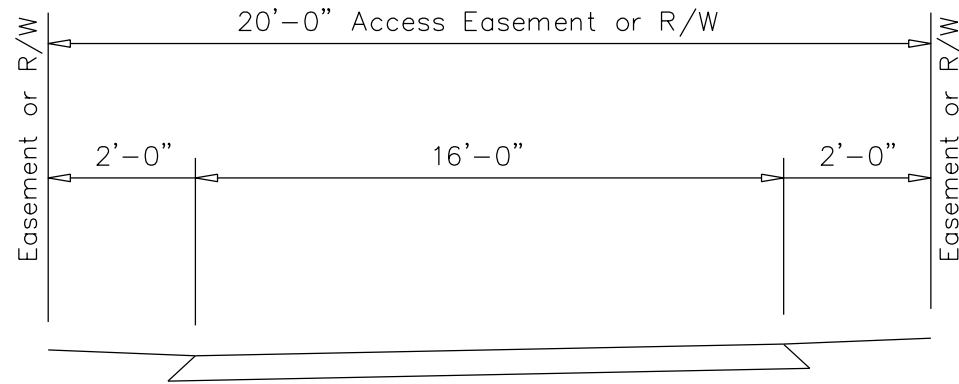
TYPICAL CROSS SECTION: RESIDENTIAL FRONTAGE ROAD




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FIGURE 2501-003



TYPICAL SECTION – LOCAL ALLEY
Scale: NTS

- NOTES:
1. If hydrants located in alley, pavement section shall be widened to 20'-0". Add'l R/W Req'd.
 2. For residential applications, see Figure 2500-001 for pavement section details.
For mixed-use or commercial applications, see Figure 2500-002 for pavement section details.
 3. Pavement may be crowned or sloped to one side, no inverted crowns.
Designer to handle drainage accordingly.
 4. If two-way traffic is allowable, pavement shall be widened to 20'-0". Add'l R/W Req'd.
 5. If utility, drainage or any other easements required, min. 10'-0" easements shall be added outside of the access easement/right-of-way.

TYPICAL CROSS SECTION: LOCAL ALLEY

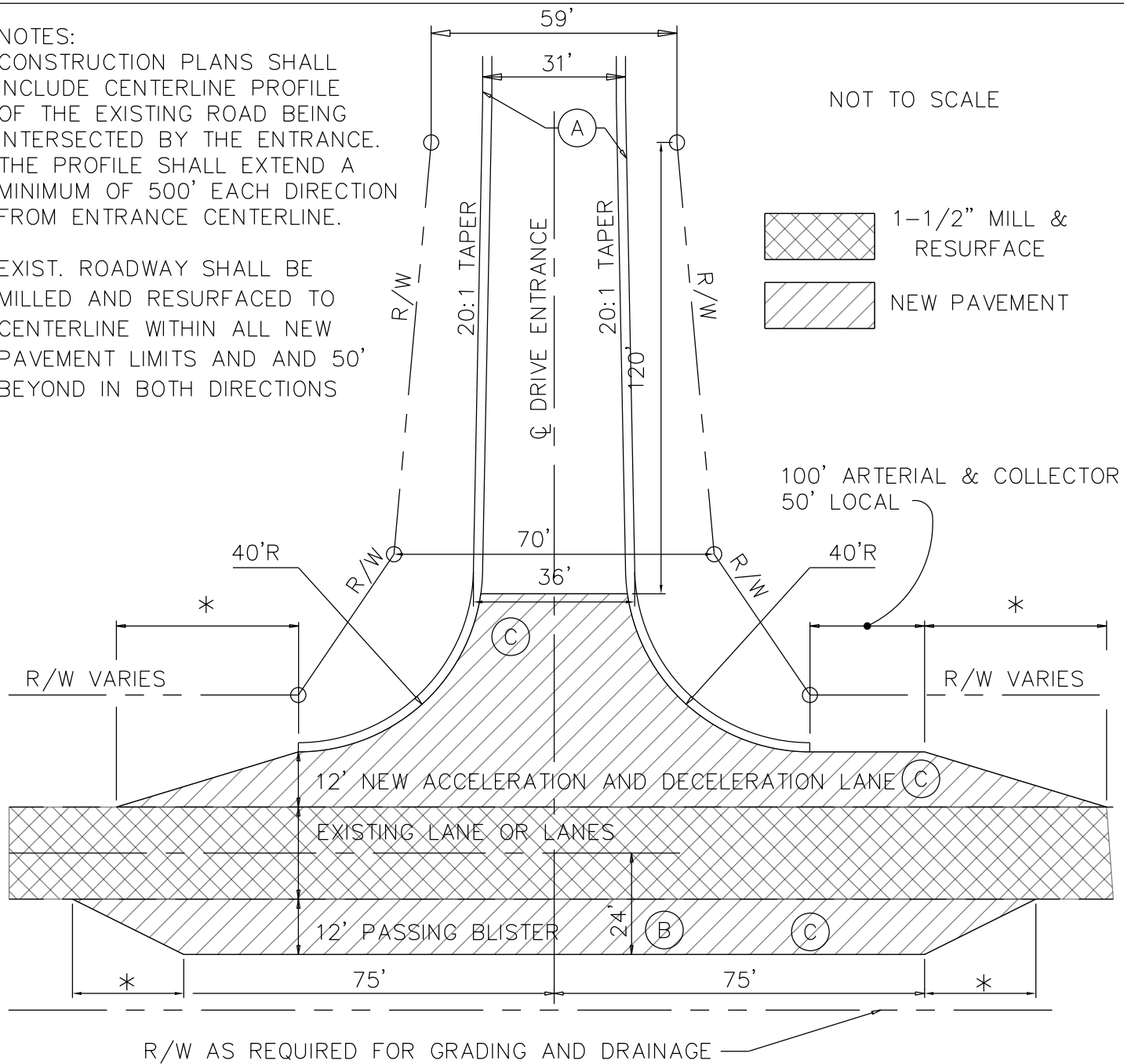


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NOTES:
CONSTRUCTION PLANS SHALL
INCLUDE CENTERLINE PROFILE
OF THE EXISTING ROAD BEING
INTERSECTED BY THE ENTRANCE.
THE PROFILE SHALL EXTEND A
MINIMUM OF 500' EACH DIRECTION
FROM ENTRANCE CENTERLINE.

EXIST. ROADWAY SHALL BE
MILLED AND RESURFACED TO
CENTERLINE WITHIN ALL NEW
PAVEMENT LIMITS AND 50'
BEYOND IN BOTH DIRECTIONS



NOT TO SCALE



1-1/2" MILL &
RESURFACE



NEW PAVEMENT

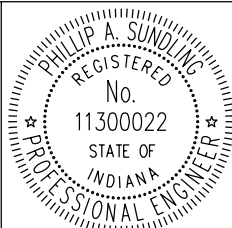
(A) 2' CURB & GUTTER

(B) PASSING BLISTER WHEN REQUIRED

(C) LANE WIDENING SHALL MATCH EXIST. PAVEMENT SURFACE TYPE

* 150' ARTERIAL
100' COLLECTOR
75' LOCAL

MIN. SUBDIVISION AND COMMERCIAL ENTRANCE CITY OF WESTFIELD, INDIANA



Phillip A. Sunding

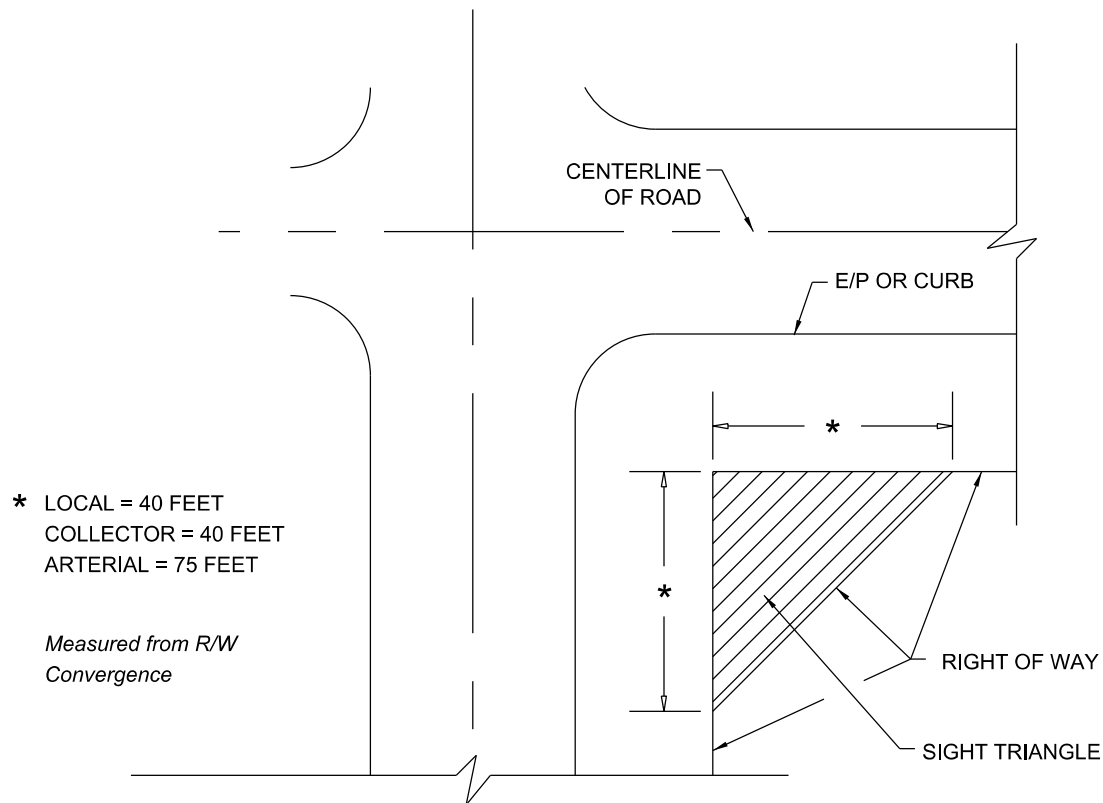
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FIGURE 2501-013



1. Cross-hatched areas shall be 6" PCCP, Class A.
2. Metal or Concrete end section shall be constructed on all pipes.
3. Subgrade under all curbs, sidewalks and drives shall be compacted in accordance with INDOTSS.
4. Sidewalks shall be constructed in accordance with the appropriate standard and shall be continuous across the driveway.
5. 20' Wide Max. for Zoning Class SF5
 20' Wide Max. for Zoning Class SF4
 26' Wide Max. for Zoning Class SF3
 30' Wide Max. for Zoning Class SF2
 30' Wide Max. for Zoning Class AG-SF-1
6. No handicap ramps permitted to fall in any portion of driveway.

FIGURE 2501-015



**SIGHT TRIANGLE FOR LOCAL, COLLECTOR,
AND ARTERIAL ROADWAYS**

NOTES:

1. NO FENCE, WALL, HEDGE, TREE OR SHRUB PLANTING WHICH OBSTRUCTS SIGHT LINES AND ELEVATIONS BETWEEN THREE (3) AND NINE (9) FEET ABOVE THE STREET SHALL BE PLACED OR PERMITTED TO REMAIN ON ANY CORNER LOT WITHIN THE TRIANGULAR AREA FORMED BY THE STREET RIGHT-OF-WAY LINES AND A LINE CONNECTING POINTS 40 FEET FROM THE INTERSECTION OF SAID STREET LINES. 40 FEET FOR COLLECTORS AND LOCAL ROADS AND STREETS; AND 75 FEET FOR PRIMARY AND SECONDARY ARTERIALS, OR IN CASE OF A ROUNDED PROPERTY CORNER, FROM THE INTERSECTION OF THE STREET RIGHT-OF-WAY LINES EXTENDED.
2. FOR PRIVATE STREETS USE 25 FEET FROM EDGE OF PAVEMENT ALONG PRIVATE STREET AND 40 FEET FROM EDGE OF PAVEMENT ALONG PUBLIC STREET.
3. FOR ANY VARIANCE FROM THIS STANDARD DRAWING, EXHIBITS IN ACCORDANCE WITH THE INDIANA DESIGN MANUAL CHAPTER 46-10.0 SHALL BE SUBMITTED TO THE WESTFIELD ENGINEER FOR REVIEW AND APPROVAL.

INTERSECTION SIGHT DISTANCE

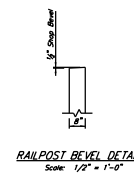
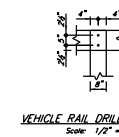
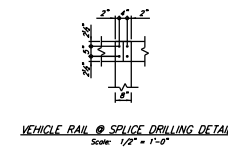
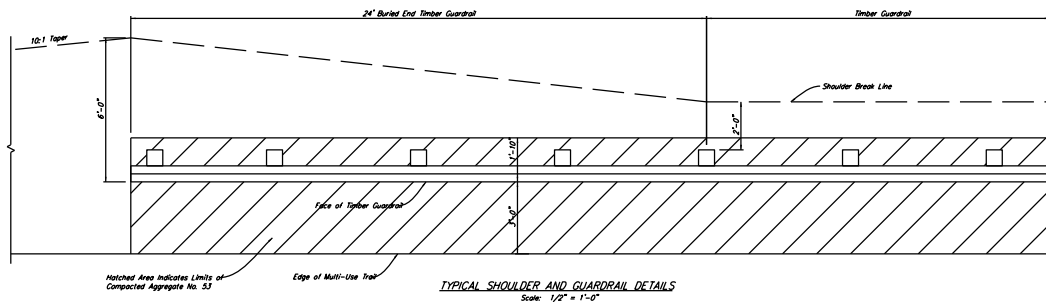
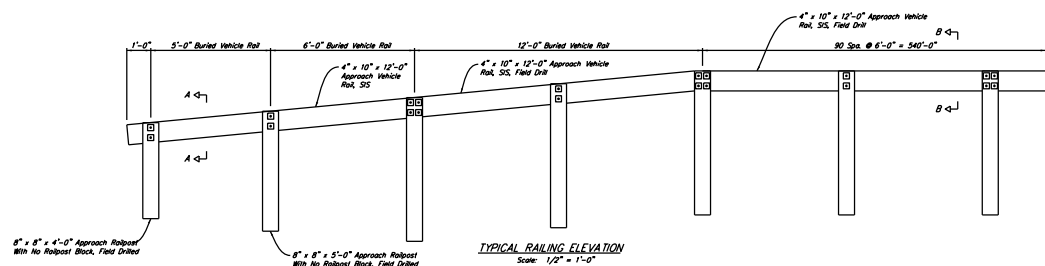
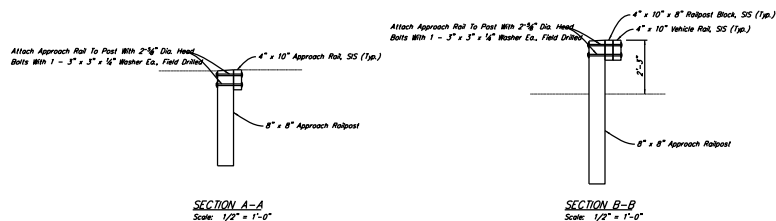
CITY OF WESTFIELD, INDIANA



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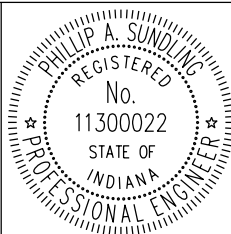
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FIGURE 2501-016



- SPECIFICATIONS**
1. ALL TIMBER SHALL BE AMPA COPPER NAPHTHENATE TREATED AS PER CURRENT STATE AND/OR AASHTO SPECIFICATIONS
 2. ALL TIMBER TO BE GRADED AS PER NFPA 1991 NATIONAL DESIGN SPECIFICATIONS FOR WOOD
- CONSTRUCTION**
1. RAILPOSTS TO BE DOUGLAS FIR-LARCH, NO. 1 POST & TIMBER
 2. 4\"/>
- CONSTRUCTION NOTES**
1. ALL HOLES DRILLED IN FIELD WHERE SPIKES ARE USED ARE 1/8\"/>

TIMBER GUARDRAIL DETAILS



Phillip A. Sundling

2/10/17
DATE

CITY OF WESTFIELD
INDIANA

FIGURE 2501-017

SECTION 02502 - STANDARDS OF ROADWAY CONSTRUCTION

PART 1 - GENERAL

1.1 Road construction shall conform to the following requirements and standards:

A. Streets, General

1. Streets and alleys shall be graded, surfaced, and improved to the dimensions required by the cross-sections and the work shall be performed in the manner prescribed in Section 02500 and the Indiana Department of Transportation Standard Specifications (INDOTSS).
2. Prior to placing the street and alley surfaces, adequate subsurface drainage (underdrains) for the street shall be provided by the Subdivider. Underdrain pipe shall conform to Section 02500.
3. Bituminous asphalt paving mixes shall comply with specifications contained in Section 02500.
4. Before any bond covering a street installation is released, the Westfield Public Works Department (WPWD) or duly authorized representative may request that core borings of the street be provided, at the Subdivider's expense, for thickness and/or compaction determination.
5. Prior to the acceptance of asphalt streets, the Subdivider shall employ and pay for the services of an independent testing laboratory to take cores at selected locations and perform Marshall stability, flow and density test, and percent of compaction determination on completed asphalt work if so directed by the WPWD or duly authorized representative.
6. Asphalt surface layer shall be placed immediately after the binder layer is installed.
7. All traffic control devices shall comply with guidelines and requirements of the current edition of the Indiana Manual on Uniform Traffic Control Devices.
8. No manhole castings or utility valve castings shall be permitted within pavement, curb or sidewalk limits. Design considerations shall be made to ensure that the castings are located outside of these areas.

B. Streets, Adjacent Roadway Improvements

1. Developers shall be responsible for improvements to the existing roadway(s) that front their property. These improvements shall include, but are not limited to, the following items:
 - a. Construction of acceleration lanes, deceleration lanes, and passing blisters for each entrance or street intersection. Refer to WSD 02500-013.
 - b. In order to construct adequate passing blisters, right-of-way shall be obtained which has a width consistent with the most current accepted Thoroughfare Plan. A minimum of 500 feet full width right-of-way centered on the entrance or street intersection shall be obtained. The developer is responsible for the purchase of the right-of-way, at fair market value. The City will offer assistance in obtaining right-of-way if the initial purchase offer is unsuccessful. A written offer to the property owner is required.
 - c. The existing two (2)-lane roadway(s) that front the property shall require a full pavement width 1-1/2" mill and resurface. The required resurfaced area shall extend a minimum of 10' beyond the acceleration and deceleration lanes and passing blister, whichever is greater.
2. Additional improvements may be required depending on field conditions and as determined by the WPWD or designee.

C. Subgrade for Street Pavements

1. Preparation
 - a. After all earth work is substantially complete and all drains installed, the subgrade shall be brought to the lines and grades shown on the plans.
 - b. Subgrade Treatment, Type IB or Type IC is required for all pavement subgrades. Refer to INDOTSS 207.04 for additional details.
 - (1) If Subgrade Treatment, Type IB is the chosen method, refer to INDOTSS 215.03 for testing and design requirements. Cement may be required in lieu of lime.

- (2) No equipment, including pickup trucks or cars, shall run over the treated areas for a minimum of 72-hour curing period.
 - (a) If this curing period is not fully met, Geogrid shall be required over the entire subgrade area throughout the treated section, unless otherwise approved by the WPWD Engineer. It is the developer's/contractor's responsibility to properly barricade off these treated areas to ensure the 72-hour curing period is upheld.
 - (b) Per INDOTSS 215.05, no chemical modifications will be allowed unless the soil has a minimum temperature of 45 degrees, measured 4 inches below the surface, and the ambient air temperature shall be rising.
- c. Unless otherwise provided, the upper six (6) inches of all subgrade shall be uniformly compacted to at least 95 percent standard density as determined by the provisions of AASHTO, T99, "Compaction and Density of Soils". During subgrade preparation and after its completion, adequate drainage shall be provided at all times to prevent water from standing on the subgrade. Subgrades shall be so constructed that it will have uniform density throughout. After compaction and final grading, the subgrade shall be finished with a three-wheel roller weighting not less than ten (10) tons. For areas not accessible to the roller, the required compaction shall be obtained by using mechanical tampers.
- d. All soft yielding or otherwise unsuitable material which will not compact properly shall be removed. All rock encountered shall either be removed or broken off to conform to required cross sections. Any holes or depressions resulting from the removal of such unsuitable material shall be filled with approved material and compacted to conform to the surrounding subgrade surface. No placement of pavement shall be permitted on uninspected or unapproved subgrade and, at no time, when the subgrade is frozen or muddy. No hauling shall be done nor equipment moved over the subgrade when its condition is such that undue distortion results. If these conditions are present, the subgrade shall be protected with adequate

plank runways, mats, or other satisfactory means if hauling is to be done thereon.

(1) The contractor may elect to install Geogrid in accordance with INDOTSS 214 to improve subgrade conditions on undercut areas. Materials shall be Tensar TX160 or approved equal.

- e. The subgrade shall be prepared sufficiently in advance to facilitate proper inspection of final elevations and compactions by the WPWD or duly authorized representative.
- f. Refer to Section 02222 for all Utility Construction requirements.

D. Pavement Section - Typical pavement sections shall conform to the requirements in Section 02500. The use of alternative cross sections shall be approved by the WPWD Engineer.

E. Underdrains

- 1. Underdrain material shall be 6-inch perforated double wall smooth bore subsurface drain pipe. It shall be cleaned and televised prior to acceptance.

F. Curbs and Gutters

- 1. Developers shall provide curbs and gutters on each side of the street in proposed development. Uncurbed roadways will not be permitted. Alley construction may be an exception to this requirement.
- 2. Curbs and gutters shall be in accordance with WSD 02500-008. As an alternate, curb sections which comply with INDOTSS will be permitted upon approval of the WPWD Engineer.
- 3. All curb and gutter sections placed on Primary Arterials, Secondary Arterials, or Collectors shall be of the barrier type. Roll-type curb and gutter sections will be permitted for Local Roads and Streets.

4. The construction of curbs, combination curb and gutter, and integral curb and gutter shall be in accordance with these specifications and as shown on the plans and shall be in reasonably close conformance with the lines and grades shown on the plans or as directed by a Professional Engineer licensed in the State of Indiana.
5. Excavation for curbs shall be made to the required depth and the subgrade or base upon which the curb is constructed shall be compacted to a firm, even surface to not less than 95% of maximum dry density as determined in accordance with AASHTO T99.
6. Concrete for curbs shall be Class A (6-bag).
 - a. Concrete testing shall be in accordance with INDOT Frequency Manual and INDOTSS 501 for air content, slump and yield. Westfield reserves the right to require the developer to provide additional third-party testing if WPWD Inspectors determine issues with the mix. WPWD Inspection personnel reserve the right to reject failed materials determined through this third-party testing as well as their own testing.
 - b. Maximum time between loading of concrete trucks and placement of materials is 90-minutes unless calcium is included in the mix which lowers this limit to 30-minutes in accordance with INDOTSS 501.14. WPWD Inspector reserves the right to reject materials if outside of these limits or if the time stamp is not included on the concrete ticket.
7. The curbs shall be constructed by the use of wood or metal forms, or a curb slip form machine. Forms, if used, shall be straight, free from warped or bent sections, and shall extend for the entire depth of the curb and shall be securely held in place so that no deviation from alignment and grade will occur during placement of concrete. The concrete shall be consolidated by vibration or other acceptable methods. The top of the curb shall be floated smooth and the top outer corner rounded to a 1/4 inch radius.
8. The face, top, and gutter of curbs shall not have deviations or irregularities of more than 1/4 inch when checked with a 10 foot straightedge.

9. Construction joints shall be placed at 10 foot intervals, unless otherwise shown or directed by a Professional Engineer licensed in the State of Indiana. The joint shall be uniform, of 1/8 to 1/4 inch in width, and to a depth of approximately 2-1/2 inches. The joint may be formed using concrete tools, saw cut or formed by approved removable strips providing a straight joint at right angles to the length of curb. If tooled joints are performed, additional saw cutting shall be required to a depth of 2-1/2 inches minimum. Construction joints shall be formed around all abutting structures such as inlets. Expansion material shall be required.
10. Curing materials shall be applied to exposed surfaces and sides of newly placed concrete within 30 minutes after the finishing operations have been completed in accordance with INDOTSS 504.04.
 - a. Only Liquid Membrane-Forming, Visible curing compounds shall be used. Clear materials shall not be permitted.
11. If cracking occurs outside of the crack-control joints, curb shall be removed from crack-control joint to crack-control joint unless otherwise approved by WPWD Inspector.
12. If existing curb is to be removed and replaced with new curb or new curb extended from existing curb, the existing curb shall be removed to the nearest joint. If HMA is placed against the curb, prior to curb removal, sawcutting the full depth of the curb face shall be required to prevent additional damage to the existing HMA. Reinforced pinning shall be required as follows:
 - a. Minimum epoxy coated rebar size: #4 Smooth
 - b. Number of bars: 2
 - c. Minimum depth of embedment: 3"
 - (1) This embedment shall be 2-part epoxied on the existing curb side if doweled in
13. During the placement of new concrete curb, utility marking shall be embossed into the top of the curb. The marking shall be a 2" high letter stamping tool and be a "D" for a subsurface drain. The stamp shall be placed into the concrete before the concrete sets up. The letters shall be located perpendicular to the utility feature that is being marked. Any stamp that is missed during installation of curb must be sandblasted in to the curb. The letters shall be located perpendicular from the utility feature that is being marked.

G. Sidewalks and Trails

1. Sidewalks shall be at least six (6) inches thick at drives and at least four (4) inches thick at all other locations within the subdivision. All Common Area sidewalk formwork shall be inspected prior to placement of any concrete. Any Common Area sidewalk placed without inspection may be removed at the discretion of the Inspection Supervisor.
2. Perimeter and Multi-use trails shall be at least eight (8) feet wide adjacent to Primary Arterials, Secondary Arterials, and Collectors and in commercial, industrial or multi-family developments and residential subdivision perimeters. Maximum grade shall not exceed 5% unless approved by the WPWD Engineer. Refer to WSD 02505-001 and 002 for additional details.
3. Sidewalks shall be at least five (5) feet wide at all other locations. Sidewalks shall be concrete in accordance with Section 02500 and 604 INDOTSS. Expansion joints shall be located every 48 feet and control joints every six (6) feet. All sidewalks shall be placed on properly prepared and compacted subgrades in accordance with this section.
4. Curb ramps, sidewalks, and multi-use trails shall comply with the most current INDOT and ADA/PROWAG requirements. Ramps shall not be permitted in driveways.
5. When sidewalks or trails cross major street intersections within or adjacent to a subdivision, necessary traffic control devices such as painted crosswalks and signs shall be installed at the subdivider's expense at the discretion of the Westfield City Council or the WPWD or designee.
6. If not located within public rights-of-way, easements in favor of the City of Westfield of at least ten (10) feet in width shall be provided for sidewalks, pedestrian trails, or bicycle trails.
7. Sidewalks shall consist of a Compacted Aggregate No. 53, Base to a depth of 3 inches and 4 inches of Concrete. Concrete sidewalk through driveways shall be 6 inches thick. Concrete shall be Class "A", 4,000 psi.
8. Compact subbase to not less than 95% of maximum dry density, as determined in accordance with AASHTO T99.

9. Proportion, mix, and place concrete as specified in INDOTSS Sections 604 and 702. Walks shall have a broom surface finish. Edge all outside edges of walk and all joints with a 1/4 inch radius edging tool.
 10. Unless otherwise shown on the drawings, walks shall be divided into sections not more than five feet in length by dummy joints formed by a jointing tool with a 1/4 inch radius.
 11. Sidewalks and handicap ramps shall conform to the most recent updated ADA/PROWAG standards. All handicap ramps shall be properly identified on the as-built drawings submitted to the WPWD.
 12. Form construction joints around all abutting structures and appurtenances such as existing manholes, utility poles, hatches, and hydrants, contractor shall install 1/2 inch thick pre-molded expansion joint filler in construction joints. Expansion joint material shall extend for the full depth of the sidewalk.
 13. If existing sidewalk is to be removed and replaced with new sidewalk or new sidewalk extended from existing sidewalk, the existing sidewalk shall be removed to the nearest joint of suitable quality or as directed by the WPWD. Reinforced pinning may be required described in this section.
- H. Easements - Whenever possible, easements for poles or underground conduits for electrical power, or communication lines shall be provided along rear lot lines.
- I. Landscaping
1. Any landscaping to be installed within the Right-of-Way shall be reviewed prior to installation.
 - a. Onsite Pre-Con shall take place prior to any installation to ensure the species defined in the plans coordinate and match what is being installed. Tags shall remain on all trees to assist in the identification by WPWD Inspector. Any installed landscaping without approval by WPWD Inspector shall be removed at Contractor's expense.
 - b. Developer shall submit for approval the Landscaping plans to Duke Energy if placed within proximity of Duke overhead facilities.

- J. Plans - Construction plans for improvements to be installed shall be furnished in accordance with the specifications of the WPWD and/or, when appropriate, to the Hamilton County Highway Department, CEG, and other necessary Agencies. Such plans must receive all appropriate approvals before improvements are installed. Upon completion of streets and alleys improvements, as-built plans in State Plane coordinates shall be filed with the WPWD after the WPWD Inspector's punchlist has been completed and, when appropriate, to the proper governing body of Hamilton County. All construction plans shall include the following:
1. Horizontal geometry of each proposed street, with centerline and curb radii shown.
 2. The profile of each proposed street, with grades indicated, and lengths of vertical curves.
 3. The cross-section of each proposed street, showing the width of pavement, the location and width of sidewalks, and the location and size of utility mains.
- K. Inspection - Prior to starting any construction, arrangements shall be made for inspection of work to ensure compliance with plans and specifications approved by the WPWD or, when appropriate, the Hamilton County Highway Department, CEG, and other necessary Agencies.
- L. All construction must be approved by the WPWD and notice of construction must be given to the WPWD, or duly authorized representative, 48 hours prior to beginning work. All approved Utility plans shall be submitted to WPDW in advance of the 48 hour notice.
- M. Allowable Modifications - Where unusual or exceptional factors or conditions exist, the WPWD may allow minor modifications of any provision of this Section. When such modifications are allowed, a detailed written statement of the reasons for such modifications shall be attached to all copies of construction plans.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

PART 4 – FIGURES

Not Applicable

END OF SECTION 02502

SECTION 02505 - STANDARDS OF TRAILS AND SIDEWALKS

PART 1 - GENERAL

- 1.1 Trail and sidewalk construction shall conform to the following requirements and standards:

A. Definitions:

1. Designated Trailhead – A designated point of access that may contain a parking area, information kiosks, restrooms, water fountains, and may be reached by vehicular or pedestrian access.
2. Perimeter Trail – A route designed, designated, or constructed within or outside street right of way for recreational use or to provide an alternative to vehicular routes within a transportation system. These trails will parallel streets designated in the current Thoroughfare Plan and provide connection to the multi-use trail system.
3. Multi-Use Trail – A facility that is physically separated from motorized vehicular traffic with an open space or barrier and either within the highway right of way or within an independent right of way. These trails are part of the Westfield Parks & Recreation Department system and are called out in the Alternative Transportation section of the current Thoroughfare Plan. A multi-use trail can be used by pedestrians, skaters, wheelchair users, joggers, bicyclists or other non-motorized users.
4. Sidewalk – The portion of a local street right of way designed for preferential or exclusive use by pedestrians.

B. Design Manuals

1. The design of Perimeter Trails, Multi-Use Trails, and Sidewalks shall follow the manuals below:
 - a. American Association of State Highway and Transportation Officials, *Guide for the Development of Bicycle Facilities*, 2012 (*AASHTO Bike Guide*) or most current edition.
 - b. Indiana Manual for Uniform Traffic Control Devices (MUTCD), 2016 or most current edition.
 - c. National Association of City Transportation Officials, *Urban Bikeway Design Guide*, 2012 (*NACTO Bike Guide*) or most current edition.
 - d. Americans With Disabilities Act and Architectural Barriers Act, *Accessibility Guidelines – 2010 Standards* (Signed March 2012 by DOJ) or most current edition.

- e. Proposed Guidelines for Pedestrian Facilities in the Public-Right-of-Way, *36 CFR Part 1190*.

C. Perimeter Trails, Multi-Use Trails, and Sidewalks:

1. Perimeter Trails shall be constructed to a minimum width of eight (8) feet. The trail shall be constructed of asphalt. The maximum design speed for these perimeter trails is 20 mph. These trails shall be constructed per Figure 02505-001.
 - a. All subgrade shall be in accordance with INDOTSS 207.
 - b. All aggregate base shall be in accordance with INDOTSS 302.
 - c. All HMA shall be in accordance with INDOTSS 402.
2. Multi-use trails shall be constructed to a minimum width of twelve (12) feet with a two (2) foot stone shoulder. The minimum design speed for these multi-use trails is 20 mph. These trails shall be constructed per Figure 02505-002.
 - a. All subgrade shall be in accordance with INDOTSS 207.
 - b. All aggregate base shall be in accordance with INDOTSS 302.
 - c. All HMA shall be in accordance with INDOTSS 402.
3. All sidewalks shall be placed on properly prepared and compacted subgrades per INDOTSS 604. These sidewalks shall be constructed per Figure 02505-010 and 02505-017.
 - a. All sidewalks shall be constructed with a minimum of 3" of compacted aggregate. Options include sand, pea gravel, No. 8 stone, and No. 53 Aggregate. Compaction shall be accomplished with a minimum of two passes with a plate compactor.
 - b. Concrete depth shall be 4" minimum. If 2"x4" forms are used, they shall be elevated to ensure 4" depth is achieved.
 - c. Sidewalks through residential driveways shall be 6" minimum.
 - d. Sidewalks through commercial driveways shall be 9" minimum.
 - e. Pinning required at the driveway/sidewalk interfaces.
 - (1) 3 #4 smooth bars, evenly spaced, 3" minimum embedment and cast-in-place, minimum 2" from the top surface.
 - f. Pinning required at lot lines tie-in.
 - (1) 3 #4 smooth bars, evenly spaced, 3" minimum embedment, minimum 2" from the top surface.
 - (2) Doweling acceptable with two-part expoy, approved by WPWD Inspector.
4. Trails, sidewalks, and curb ramps shall comply with the most current INDOT and ADA/PROWAG requirements.

5. All perimeter trails or multi-use trails shall be placed on properly prepared and compacted subgrades. Materials shall be furnished and installed in accordance with Section 02500 and INDOTSS. All perimeter trails or multi-use trails shall be proof roll tested with a WPWD Inspector or representative present during testing. All proof roll testing requires at least a 48 hour notification prior to testing to the WPWD.
 6. Where perimeter trails and multi-use trails intersect streets designated in the current Thoroughfare Plan, the streets must have signage and traffic control devices that meet current MUTCD standards and shall be installed at the developer's expense. When required, coordination and permitting with INDOT is also at the expense of the developer.
 7. The perimeter trails, multi-use trails, & sidewalks shall intersect the road at a 90 degree angle, where possible, but may not be less than 45 degrees.
 8. Clear intersection sight lines shall be provided for both the motorist and the trail user. See Figure 02505-003 for additional details.
 9. If not located within public rights-of-way, an easement of at least ten (10) feet in width shall be provided for sidewalks and perimeter trails.
- D. Allowable Modifications - Where unusual or exceptional factors or conditions exist, the City of Westfield may allow minor modifications of any provision of this Section. When such modifications are allowed, a detailed written statement of the reasons for such modifications shall be attached to all copies of construction plans.
- E. Drainage:
1. All trails must have a 2% cross slope. A smooth surface is essential to prevent water ponding or ice formation.
 2. Where a multi-use trail is constructed on the side of a hill, a swale or other storm water collection system of approved dimensions must be placed on the uphill side to collect the hillside drainage. Such swale must be designed so that an undue obstacle cannot interfere with trail use. Where necessary, a catch basin with drains shall be provided to carry the collected water under the trail. Drainage grates must be located outside the trail. All drainage-structure grates must be designed for all wheeled traffic.
 3. The minimum diameter of a culvert which conveys flow under a multi-use trail shall be 12 inches. Each culvert shall be designed to pass a minimum 2-year flood event.

F. Waterway Crossings:

1. Permitting - A structure crossing a waterway is required to obtain all federal, state, county, and local permits and approvals.
2. Allowable bridge decking products include:
 - a. Structural concrete slab for multi-use trails
 - b. City of Westfield approved treated wood products or concrete for perimeter trails.
 - c. Alternatives must be sent to the Westfield Parks & Recreation Department for evaluation. These alternatives must also be accompanied by a data sheet, provided by the manufacturer, stating that the product is designed for the proposed use.
3. All bridges on multi-use trails shall be designed to structurally support 10,000 pounds.
4. All bridge designs must be reviewed by a professionally licensed structural engineer selected by the City of Westfield, at the expense of the Developer.

G. Railings:

1. Trail Railing
 - a. Design of railings is based on specifications located in Figures 02505-04 and 02505-05.
 - b. All trail railings shall be 54 inches in height.
 - c. Design loading shall be $W=50$ pounds per linear foot transversely and vertically, acting simultaneously on each rail.
 - d. Any opening in railing elements shall not allow a 6-inch diameter sphere to pass through.

H. Bollards or gates shall be used on a case by case basis. Location of bollards or gates must be approved by the Westfield Parks & Recreation Department.

I. Multi-Use Trail Signage:

1. Trail identification and informational signage and sign specifications are called out in the Westfield Parks & Recreation Trail Standards.

J. Multi-use trail access points must be approved by the Westfield Parks & Recreation Department, as outlined in Policy PK 06-11, per Ordinance 11-22.

K. Curb Ramps:

1. All curb ramps shall be in accordance with INDOTSS 604.
2. Detectable Warning Elements (truncated domes) shall be:
 - a. Cast-in-place
 - b. Material: Vitrified Polymer Composite (plastic)
 - c. Products:
 - i. <http://www.adatile.com/castinplace.php>
 - ii. <http://www.armor-tile.com/cast-in-place.html>
 - iii. Approved Equal
 - d. Meets or exceeds HS20 loading requirements
 - e. Color: Brick Red or approved equal
 - f. Cut to conform to angles – gaps shall not exceed 1/8"
 - g. Plates shall be placed directly along the back of the 6" curb per INDOT Std. Dwg. No. E 604-SWCR-03
3. All curb ramps shall include detectable warning grooving
4. Depth of concrete at curb shall be in accordance with INDOT Std. Dwg. No. E 604-SWCR-02

L. Driveways:

1. All residential driveways shall be in accordance with INDOT Std. Dwg. No. E 610-DRIV-01 for Class I Drives
 - a. In lieu of the radii, 1:1 tapers are acceptable
 - b. Absolutely no ADA ramps shall be constructed within the limits of the driveway. 2' minimum separation between driveway and curb ramp.
 - c. Profiles shall in accordance with INDOT Std. Dwg. No. E 610-DRIV-08. 6" concrete on 6" of No. 53 stone.
2. All commercial driveways shall be in accordance with INDOT Std. Dwg. No. E 610-DRIV-03 for Class III Drives
 - a. Corner/radii construction shall be in accordance with INDOT Std. Dwg. No. E 610-DRIV-16
 - b. Profiles shall in accordance with INDOT Std. Dwg. No. E 610-DRIV-08.

PART 2 – PRODUCTS

Not applicable

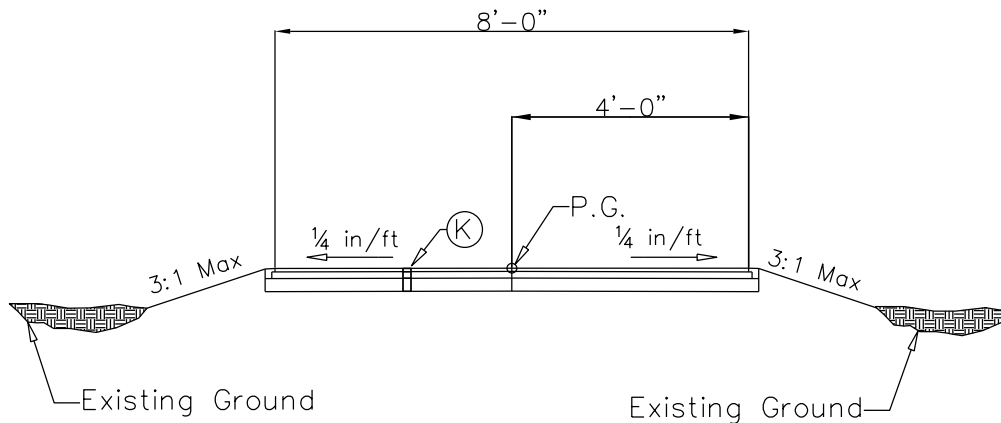
PART 3 – EXECUTION

Not applicable

PART 4 - FIGURES

<u>FIGURE</u>	<u>DESCRIPTION</u>
02505-001	Typical Cross Section – Perimeter Trail
02505-002	Typical Cross Section – Multi-Use Trail
02505-003	Typical Cross Section – Line of Sight Triangle
02505-004	Typical Cross Section – Wood Railing Details
02505-005	Typical Cross Section – Wood Railing Details

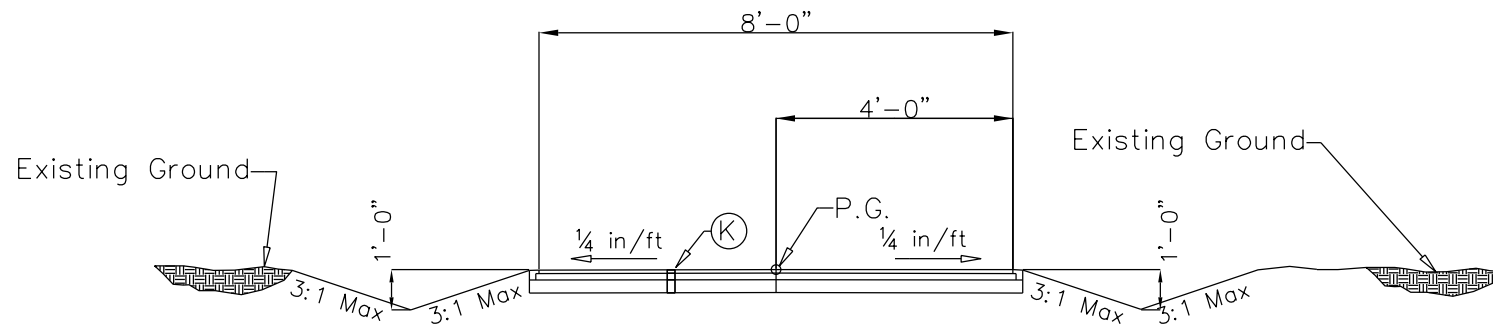
END OF SECTION 02505



TYPICAL TRAIL FILL SECTION

LEGEND

- (K) 330#/SYS HMA, TYPE B, SURFACE, 12.5MM ON 6" COMPACTED AGG, NO. 53, BASE

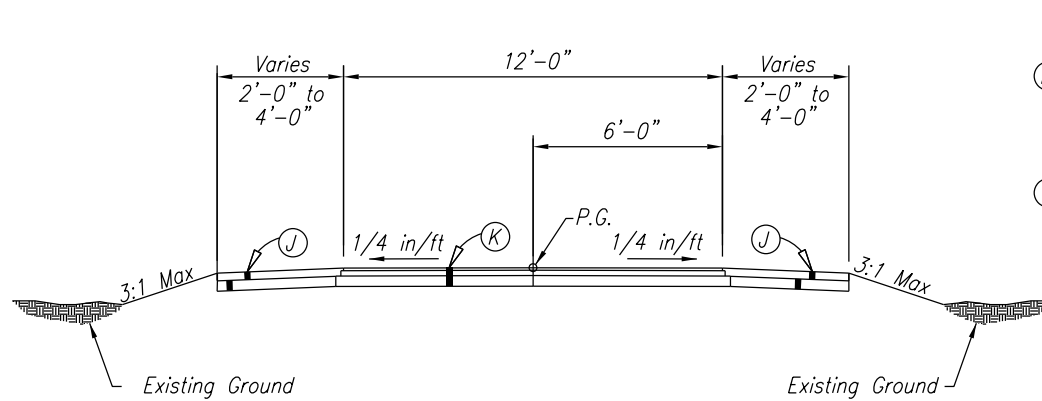


TYPICAL CROSS SECTION – PERIMETER TRAIL



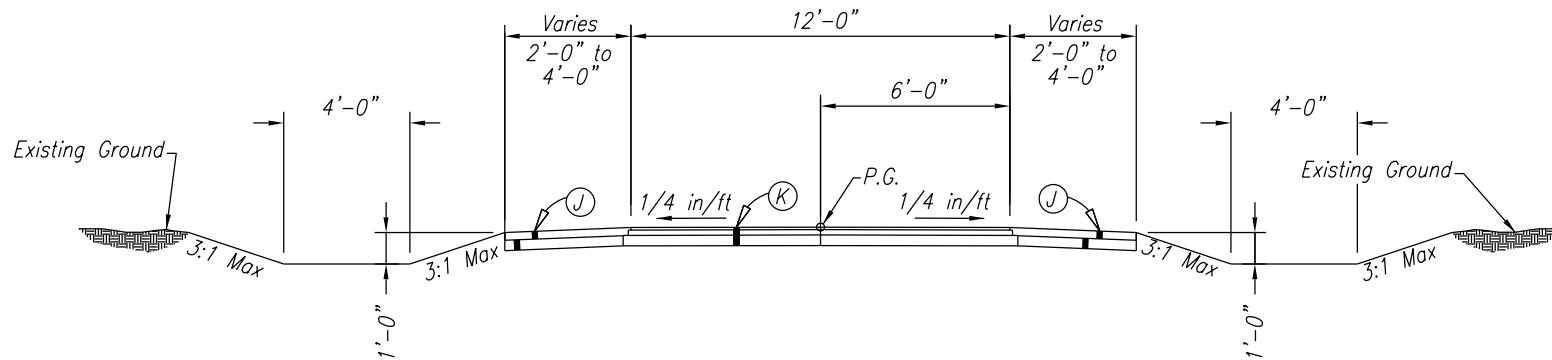
[Signature] 2/26/16
DATE

CITY OF WESTFIELD
INDIANA



TYPICAL TRAIL FILL SECTION
SCALE = NONE

- LEGEND
- (K) 165#/SYS HMA, TYPE A, SURFACE, 9.5MM
275#/SYS HMA, TYPE A, INTERMEDIATE, 19.0MM
6" COMPACTED AGG., NO. 53, BASE
 - (J) 10" COMPACTED AGG., NO. 53



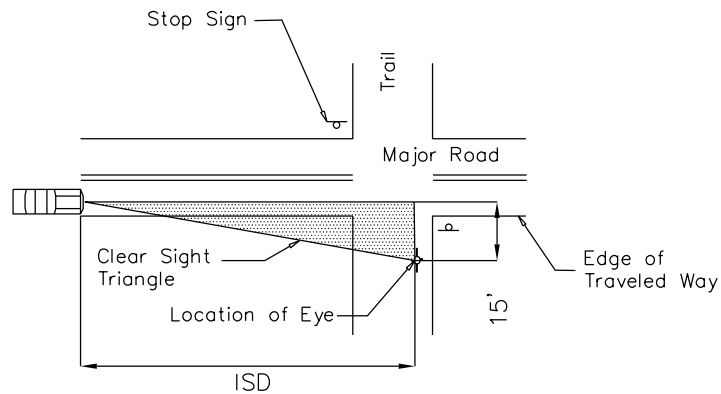
TYPICAL TRAIL CUT SECTION
SCALE = NONE

TYPICAL CROSS SECTION – PERIMETER TRAIL



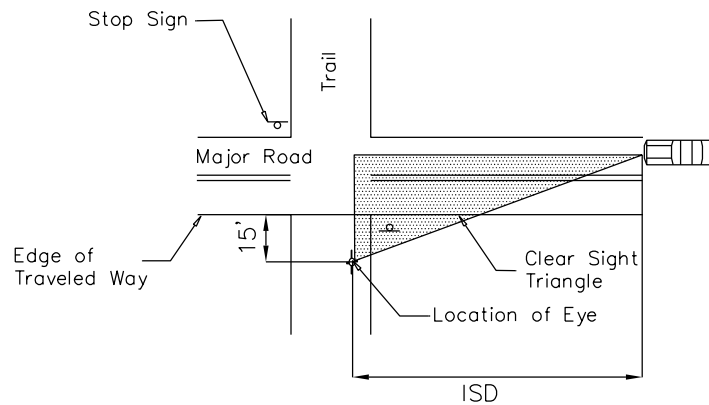
[Signature]
2/26/16
DATE

CITY OF WESTFIELD
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CLEAR SIGHT TRIANGLE FOR VIEWING
TRAFFIC APPROACHING FROM THE LEFT

US Customary	
Design Speed (mph)	ISD (ft)
20	225
25	280
30	335
35	390
40	445
45	500
50	555
55	610
60	665



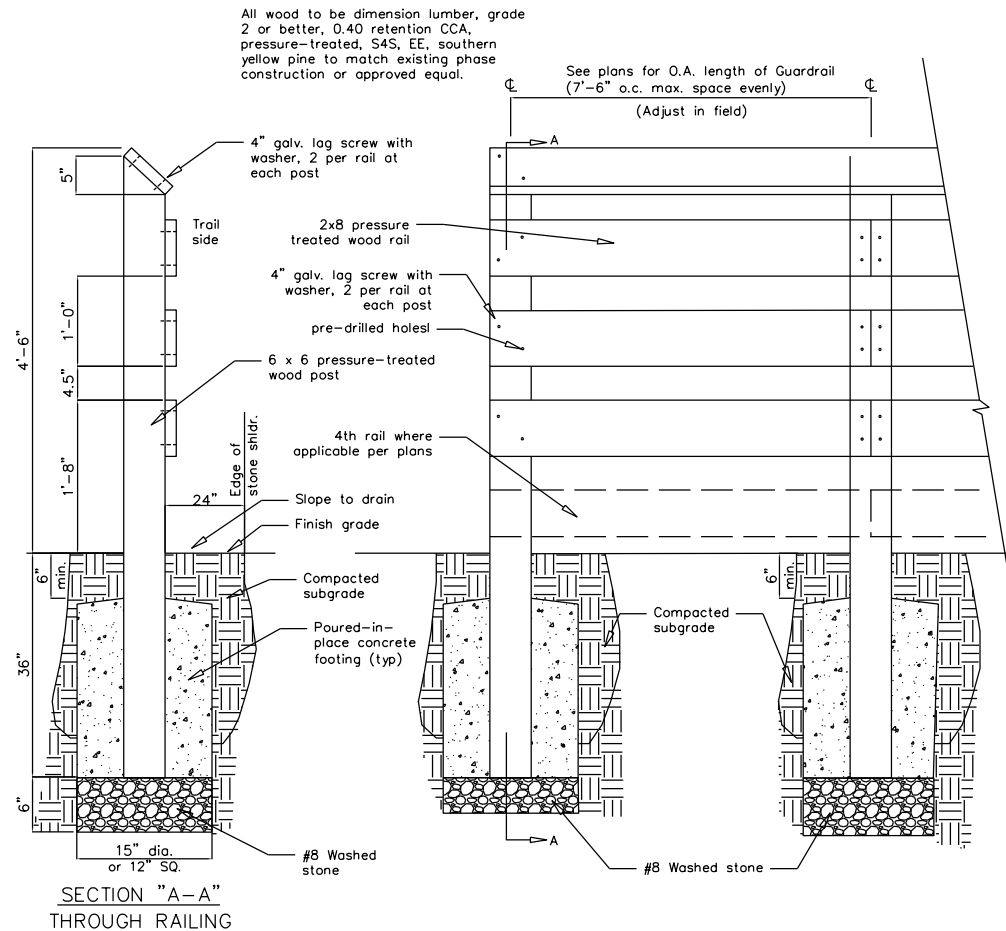
CLEAR SIGHT TRIANGLE FOR VIEWING
TRAFFIC APPROACHING FROM THE RIGHT

TYPICAL TRAIL SECTION – LINE OF SIGHT TRIANGLE



Phillip A. Sundling
2/26/16
DATE

CITY OF WESTFIELD
INDIANA



TYPICAL TRAIL SECTION – WOOD RAILING DETAILS



Phillip A. Sundling

2/26/16
DATE

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FIGURE 2505-005

SECTION 02750 – STORM SEWER TELEVISION

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers all work necessary for the cleaning and televising of storm sewers, and all subsurface drains to determine the watertightness, connections, alignment, grades and locations of service.
- B. The type of equipment required for the work and the methods of accomplishing the work, as well as the type of materials to be incorporated into the work, are covered in this Section.
- C. Prior to televising, all storm sewer pipe and subsurface drains shall be cleaned via a water jetting method. The Contractor shall introduce enough water into sewer pipe to indicate bellies or sags in line being televised. Said water shall be placed after the line has been cleaned and prior to televising. Televising while cleaning shall not be permitted.
- D. All cleaning and televising shall be performed after all underground utilities are installed; including but not limited to gas, electric, phone, and cable.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIRED

- A. The Contractor shall furnish all labor, electronic equipment, and technicians to perform the closed circuit television inspection of the sewers. Operation of the equipment is to be controlled from above ground with a skilled technician at the control panel in the television studio, controlling the movement of the television camera through the sewer in either direction.
- B. The color television camera shall be one specifically designed and constructed for the purpose of televising sewers. The color camera shall have a high resolution lens capable of spanning 360 degrees circumference and 270 degrees on horizontal axis to televise sewer lines 6 inches in diameter and larger. Focal distance shall be adjustable through a range of 1 inch to infinity. The purpose of the rotating head camera is to view all service connections and to locate all defects, as well as any questionable problem areas. The camera shall be mounted to a self-propelled crawler/transporter.

- C. Camera lighting quality shall be suitable to provide a clear, continuously in focus picture of the entire inside periphery of the sewer pipe for all conditions encountered during the work. The camera shall be able to operate efficiently in 100% humidity conditions. The camera, television monitor, and all other necessary components of the video system shall be capable of producing a minimum 350-line resolution color video picture.
- D. The view seen by the television camera shall be transmitted to a color monitor of not less than 17 inches and to a DVD, thumb drive, or other type of portable storage approved by the Utility, WPWD Inspectors, and/or designee. The TV camera shall have the capability of transmitting a color picture with no less than 600 lines of resolution, the monitor shall have the capability of receiving the same. The monitor shall be located inside a mobile TV studio.
- E. Contractor shall supply digital video to client on to a DVD, thumb drive, or other type of portable storage approved by the Utility, WPWD Inspectors and/or designee:
 - 1. Minimum 640 x 480 pixel dimension
 - 2. Minimum 24 fps (frames per second)
 - 3. Indexed chapters to allow instant access to points of observation
 - 4. Cross-platform compatible to allow for viewing on any operating system
- F. The Contractor's mobile studio shall be large enough to accommodate up to three people for the purpose of viewing the monitor while the inspection is in progress. The Utility, WPWD Inspectors, or designee shall have access to view the television screen at all times.
- G. The Contractor will provide one clear copy of the video/television inspection to the Utility, WPWD Inspectors and/or designee with complete log sheets.
- H. The technician will provide text input at the time of inspection pointing out cracks, root intrusion, broken tile, infiltration and any other items pertinent to the evaluation of the sewer line.
- I. Upon completion of all sewer inspection, the Contractor shall furnish to the Utility, WPWD Inspectors, or designee a hard copy of a computerized report. This report will be generated by an onboard computer and printer and will provide commentary. The report will describe all other pertinent findings regarding service connections, breaks or cracks in pipes, bellies or sags, infiltration, and other items of interest.

1. The City of Westfield reserves the right, at their discretion, to request additional laser micrometer testing for concrete pipe in accordance with AASHTO LRFD Bridge Construction Specification Section 27.6.4 and 5.

- J. Storm sewer and subsurface drain inspection videos, logs, and reports shall be done on separate media and submitted separately.

PART 3 - EXECUTION

Not Applicable

PART 4 – FIGURES

Not applicable

END OF SECTION 02750

SECTION 02800 – STREET TREE LIST

Table 1

Preferred Street Trees

Large/ Medium Tree List

Trees from Table 1 will eventually reach a height of between thirty (30) to eighty (80) feet in most urban situations. Variations of the plant selections not included on the *Preferred Shade Tree List* may be approved through the City’s designee. Improved cultivars, seedless, and/or thornless varieties **must** be used when available. Locally grown stock is advised to improve tree survival rates. Minimum caliper of 2 inches is required for all Shade Trees at installation unless otherwise specified.

STREET TREES (TYPE A)

COMMON NAME	SCIENTIFIC NAME
Coffeetree, Kentucky Elm, Accolade Ginkgo	<i>Gymnocladus dioica</i> (male only) <i>Ulmus ‘Morton’</i> <i>Ginko biloba</i> (male only)
Hackberry Honeylocust (thornless) Horechestnut, Red Katsurstree	<i>Celtis occidentalis</i> <i>Gleditsia triancanthos</i> var. <i>inermis</i> , seedless cultivars <i>Aesculus x carnea ‘Briotii’</i> <i>Cercidiphyllum japonicum</i>
Linden, Silver ‘Sterling Silver’ Maple, Black Maple, Freeman	<i>Tilia tomentosa ‘Sterling Silver’</i> <i>Acer nigrum</i> <i>Acer freemanii</i>
Maple, Red Maple, Sugar Maple, Sycamore	<i>Acer rubrum</i> <i>Acer saccharum</i> <i>Acer pseudoplatanus</i>
Oak, Chinkapin Oak, Northern Red Oak, Shingle	<i>Quercus muehlenbergii</i> <i>Quercus rubra</i> <i>Quercus imbricaria</i>
Oak, Swamp White Oak, White Sweetgum	<i>Quercus bicolor</i> <i>Quercus alba</i> <i>Liquidambar styraciflua</i>
Tulip Zelkova	<i>Liriodendrom tulipifera</i> <i>Zelcova serrata</i>

Table 2
Alternative/ Substitute Trees
Small Tree List

Trees from Table 2 will eventually reach a height of between fifteen (15) to thirty (30) feet in most urban situations. The *Alternate/ Substitute Tree List* may be used with the approval of the City’s designee under circumstances not conducive to trees listed in Table 1 (i.e. overhead power lines, narrow planting strips).

*See note below.

COMMON NAME	SCIENTIFIC NAME
Cherry, Cornelian Crabapple Var. Hawthorn Var.	<i>Cornus mas</i> <i>Malus var.</i> <i>Crataegus crusgalli var.</i>
Hornbeam, American Hornbeam, European Ironwood	<i>Carpinus caroliniana</i> <i>Carpinus betulus</i> <i>Ostrya virginiana</i>
Japanese Lilac Maple, Amur Maple, Hedge	<i>Syringa reticulata</i> <i>Acer ginnala (single stem)</i> <i>Acer campestre</i>
Maple, Paperbark Redbud Serviceberry	<i>Acer griseum</i> <i>Cercis canadensis</i> <i>Amelanchier var.</i>

Note:

Improved cultivars and seedless, thornless varieties **must** be used when available. Locally grown tree stock is advised to improve tree survival rates. Small trees used as street trees must be upright/ columnar; not clump form. Most small trees are not suitable for narrow tree lawns due to low branching habits. Minimum size for trees required by the Landscape Standards is two (2) inch caliper at time of installation

CITY OF WESTFIELD

Stormwater Management Technical Standards Manual

March 2017

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03500	INSTALLATION OF STORMWATER FACILITIES
03600	EROSION AND SEDIMENT CONTROL FOR CONSTRUCTION SITES
03700	POST-CONSTRUCTION STORMWATER QUALITY MANAGEMENT

CHAPTER 03100 POLICY AND PROCEDURES

SECTION 03101 INTRODUCTION

03101.01
Section
Purpose

This manual provides technical standards for proper stormwater management and stormwater quality practices for those engineers, builders, contractors, land planners, and property owners contemplating some form of land alteration or improvement within land areas under the City of Westfield Municipal MS4 Stormwater Jurisdiction. This Stormwater Technical Standards Manual is intended to establish the policies relating to stormwater management, stormwater quality practices, and flood control, submittal requirements and procedures for issuance of a stormwater permit, and procedures for inspection, testing and final acceptance of stormwater facilities.

The contents of the Manual are the result of a joint effort by Hamilton County, the City of Carmel, the Town of Fishers, the City of Noblesville, and the City of Westfield. The regulations have been established to accomplish the following objectives:

- Provide for consistent, high quality project design and evaluation by consolidating current departmental standards and “policies” within a single document.
- Establish minimum requirements and standards for stormwater management plan submittals and project reviews.
- Facilitate more consistent review of stormwater permit applications and land alteration plans by the stormwater permit staff.
- Establish a standard for the proper and consistent installation of stormwater facilities, with a high level of workmanship, according to the approved stormwater management plan.
- Minimize the impacts of new development and redevelopment projects on existing stormwater management facilities.

This Manual was developed with the assumption that the user will possess a basic understanding of civil engineering design, construction, stormwater quality practices, or land alteration, depending upon the users particular area of expertise. Readers of the Manual which are not qualified by education and experience in the field of construction, engineering, stormwater quality practices, or land alteration should consult with a more qualified person or persons possessing professional expertise in one or more of these fields prior to application of the requirements set forth herein.

03101.02
Provisions

This Manual, together with all future revisions, shall be referred to as “**The City of Westfield Stormwater Management Technical Standards Manual**”. The City of Westfield has been granted authority to “protect the safety, health, and general welfare of the citizens” of the City of Westfield by requiring compliance with standards and practices, which result in proper stormwater drainage and sediment control in the accomplishment of land alterations or other improvements.

03101.03
Applicability

The provisions of this Manual shall apply to the following areas within Hamilton County:

1. **All territory of the County that is not located within a municipality;**
2. **All territory of a municipality located within the County that has adopted a policy or resolution that the territory of the municipality or a portion of the territory of a municipality be included within the applicability area of this Manual;**

3. All areas within a municipality which lie within the drainage shed of a regulated drain.

This Manual applies to all land altering projects as stated and defined in the City of Westfield Ordinance Number 05-30 (An Ordinance to Establish Overlay Zone Districts and Regulations for Storm Water Management). Any land alteration, within the jurisdiction of this Manual, must be accomplished in conformity with the stormwater requirements set forth herein. "Land Alteration" shall generally refer to any on-site or off-site action taken relative to land which either:

1. Changes the contour; or
2. Increases the runoff rate or volume; or
3. Changes the elevation; or
4. Decreases the rate at which water is absorbed; or
5. Changes the drainage pattern; or
6. Creates or changes a stormwater facility; or
7. Involves construction, enlargement, location or relocation of any building on a permanent foundation; or
8. Increases the delivery of point and/or non-point source pollution to streams; or
9. Relocates, encloses, or alters a stream or open channel stormwater conveyance; or
10. Creates an impoundment.

This Manual should be used in conjunction with the applicable City of Westfield stormwater management ordinances. Additional requirements related to land alteration may be found in the existing codes and ordinances of the City of Westfield. Exceptions to the provisions of this Manual are provided in the applicable City of Westfield stormwater management ordinances.

When the project site that is located within the drainage shed of a Hamilton County Regulated Drain falls within the corporate limits of a municipality, adherence to the requirements of both entities is required. In case there is a conflict between the requirements of the municipality and those of the County, the most restrictive requirements shall apply.

03101.04
Stormwater
Manual
Organization

This Manual is organized to present the technical and engineering procedures and criteria needed to comply with the land areas under the City of Westfield government jurisdiction stormwater regulations. Copies of the City of Westfield's pertinent stormwater management ordinances are presented in the Appendices of this Chapter. In addition, the general design policy and procedures are presented.

Each chapter of this Manual contains an initial section that presents all of the policies and procedures that must be satisfied for approval. These policies and procedures shall be considered as design criteria that are unique for approval within the jurisdiction of this Manual.

The site designer is encouraged to review the LID discussion in Chapter 03700 prior to the site design to take advantage of runoff reduction recognitions provided towards water quantity calculations discussed in earlier chapters if LID practices are utilized as part of the site design.

03101.05
Updating

The process of updating this Manual shall be adopted as policy by the City of Westfield. This Manual shall be periodically updated and revised, as necessary, to reflect current engineering practices and information applicable to land areas under the City of Westfield government jurisdiction. Users of this Manual are encouraged to obtain any and all updates and supplements to this Manual each time a land alteration project is considered. The ultimate responsibility for checking for and obtaining updated material shall be the responsibility of the user.

The most current standards shall be required for approval of a land alteration. The incorporation of outdated standards in the design, implementation, and construction of a land alteration shall be cause for the City of Westfield to reject the proposed land alteration.

SECTION 03102 PERMIT REQUIREMENTS AND PROCEDURES

03102.01
Introduction

The project site owner shall submit an application for a stormwater management permit to the City of Westfield. The application will include a Draft Notice of Intent letter (NOI) that would also act as permit application form if the project site is one (1) acre or more to be disturbed, construction plan sheets, stormwater drainage technical report, operations and maintenance manual, a stormwater pollution prevention plan, and any other necessary support information. Specific information to be included in the application can be found in Section 03102.03 below. One (1) copy of each required application material must be submitted to the Westfield Public Works Department (WPWD). The original Rule 5 NOI should also include the original proof of publication and a \$100 check made out to IDEM. Additionally, a digital copy of the construction plans is required in a format accepted by the WPWD. All plans, reports, calculations, and narratives shall be signed and sealed by a professional engineer or a licensed land surveyor, registered in the State of Indiana.

After the WPWD receipt of the application, the applicant will be notified as to whether their application was complete or insufficient. The applicant will be asked for additional information if the application is insufficient. All plans, reports, calculations, and narratives shall be signed and sealed by a professional engineer or a licensed land surveyor, registered in the State of Indiana. The information provided will be reviewed in detail by WPWD and/or its plan review consultant(s). Once all comments have been received and review completed, the WPWD will either approve the project or request modifications.

For the WPWD, copies of the final, approved construction plans, stormwater drainage technical report, operations and maintenance manual, stormwater pollution prevention plan for construction sites, and post-construction stormwater pollution prevention plan shall also accompany the above-noted written notification and proof of publication. The number of required copies varies from case to case and should be determined by contacting the WPWD. A pre-construction meeting is required to be held with the participation of the WPWD and other entities involved prior to any grading activity to ensure that appropriate perimeter control measures have been implemented on the site and the location of any existing tiles has been properly marked.

Once construction starts, the project owner shall monitor construction activities with a maintenance log and inspect all stormwater pollution prevention measures in compliance with the City of Westfield's applicable ordinances and the terms and conditions of the approved permit. Upon completion of construction activities, as-built plans in state plan coordinates on CD must be submitted to the WPWD. A Notice of Termination (NOT) shall be sent to the WPWD once the construction site has been stabilized and all temporary erosion and sediment control measures have been removed. The WPWD, or a representative, shall inspect the construction site to verify the requirements for a NOT have been met in accordance with the Rule 5 (327 IAC 15-5). Once the applicant receives a "verified" copy of the NOT, they must forward a copy to IDEM. Permits issued under this scenario will expire 5 years from the date of issuance. If construction is not completed

within 5 years, the NOI must be resubmitted at least 90 days prior to expiration. A flow chart of the major steps in the stormwater plan review/permit process is provided as Exhibit 03102-1.

Specific projects or activities may be exempt from all or part of the informational requirements listed below. Exemptions are detailed in the applicable ordinances and “Applicability and Exemptions” Sections of Chapters 03200 through 03700. If a project or activity is exempt from any or all requirements of the ordinances or this Manual, an application should be filed listing the exemption criteria met, in lieu of the information requirements listed below. The level of detailed information requested below is not required from individual lots, disturbing less than 1 acre of land, developed within a larger permitted project site. Review and acceptance of such lots is covered under Section 03102.07 of this Chapter.

In order to gain an understanding of the stormwater management requirements for a specific project, a developer or his/her engineer may submit conceptual drainage plans and calculations to the WPWD and request an informal meeting to discuss the proposed project. The direction provided by the WPWD as a result of such a review is based on preliminary data and shall not be construed as an approval or binding on either party.

03102.02
Draft Notice of
Intent

The NOI is a standard form developed by the Indiana Department of Environmental Management which requires general project information. As part of the WPWD Stormwater Management Permit application package, the NOI form should be completed in full based on data and information available at the time of application.

Accompanied by proof of publication in a newspaper of general circulation in the affected area that notified the public that a construction activity is to commence must include the following language:

“(Company name, address) is submitting an NOI letter to notify **the City of Westfield and the Indiana Department of Environmental Management** of our intent to comply with the requirements of **the applicable City of Westfield stormwater management ordinances**, as well as the requirements of 327 IAC 15-5 and 327 IAC 15-13, to discharge stormwater from construction activities for the following project: (name of the construction project, address of the location of the construction project, and Parcel Identification Number). Run-off from the project site will discharge to (stream(s) receiving the discharge(s)).”

03102.03
Construction
Plans

Construction plan sheets not to exceed 24” by 36” in size) with a scale of 1 inch = 20 feet, 30 feet, 40 feet, 50 feet or 60 feet, and an accompanying narrative report shall describe and depict the existing and proposed conditions. Note that in order to gain an understanding of and to evaluate the relationship between the proposed improvements for a specific project section/phase and the proposed improvements for an overall multi-section (phased) project, the detailed information requested herein for the first section/phase being permitted must be accompanied by an overall project plan that includes the location, dimensions, and supporting analyses of all detention/retention facilities, primary conveyance facilities, and outlet conditions. Construction plans need to include the following detailed items:

- i. Title sheet which includes location map, vicinity map, operating authority, design company name, developer name, and index of plan sheets.
- ii. A copy of a legal boundary survey for the site, performed in accordance with Rule 12 of Title 865 of the Indiana Administrative Code or any applicable and subsequently adopted rule or regulation for the subdivision limits, including all drainage easements and wetlands.

- iii. A reduced plat or project site map showing the parcel identification numbers, lot numbers, lot boundaries, easements, and road layout and names. The reduced map must be legible and submitted on a sheet or sheets no larger than eleven (11) inches by seventeen (17) inches for all phases or sections of the project site.
- iv. An existing project site layout that must include the following information:
 - a. A topographic map of the land to be developed superimposed on a County GIS ortho-aerial map at a scale of 1"=100'. The exhibit should provide the contour information and include all roads and buildings within a minimum 500' radius beyond the project boundaries. The contour intervals for the land to be developed shall be one (1) foot when slopes are less than or equal to two percent (<2%) and shall be two (2) feet when slopes exceed two percent (>2%). All elevations shall be given in North American Vertical Datum of 1988 (NAVD). The horizontal datum of topographic map shall be based on Indiana State Plane Coordinates, NAD83. The map will contain a notation indicating the noted datum information. The names of adjoining property owners must be labeled on the map.
 - b. Location, name, and normal water level of all wetlands, lakes, ponds, and water courses on or adjacent to the project site.
 - c. Location of all existing structures on the project site.
 - d. One hundred (100) year floodplains, floodway fringes, and floodways. Please note if none exists.
 - e. Identification and delineation of vegetative cover such as grass, weeds, brush, and trees on the project site.
 - f. Location of storm, sanitary, combined sewer, and septic tank systems and outfalls.
 - g. Land use of all adjacent properties.
 - h. Identification and delineation of sensitive areas.
 - i. The location of regulated drains, farm drains, inlets and outfalls. Prior to construction plan design beginning, all existing regulated drains on the site are to be located, exposed, and invert shots taken to ensure the system is installed deep enough to provide drainage to the upstream watershed. This is also applicable if the site outlets into a regulated drain and no as-built drawings on the drain exist.
 - j. Location of all existing cornerstones within the proposed development and a plan to protect and preserve them.
 - k. Location of all known wells (including abandoned wells).
 - l. Location of known potential contaminant facilities.
- v. A grading and drainage plan, including the following information:
 - a. All information from the existing site layout items listed above.
 - b. Location of all proposed site improvements, including roads, utilities, lot delineation and identification, proposed structures, finished floor elevations, and common areas with elevations for those improvements.
 - c. One hundred (100) year floodplains, floodway fringes, and floodways. Please note if none exists.
 - d. Delineation of all proposed land disturbing activities, including off-site activities that will provide services to the project site.
 - e. Information regarding any off-site borrow, stockpile, or disposal areas that are associated with a project site, and under the control of the project site owner.
 - f. Proposed topographic information at one-foot contour interval.
 - g. Location, size, and dimensions of all existing streams to be maintained, and new drainage systems such as culverts, bridges, storm sewers, conveyance

- channels, and 100-year overflow paths/ponding areas shown as hatched areas, along with all associated easements.
- h. Pipes and associated structures data, including sizes, lengths, and material
 - i. Location, size, and dimensions of features such as permanent retention or detention facilities, including natural or constructed wetlands, used for the purpose of stormwater management. Include existing retention or detention facilities that will be maintained, enlarged, or otherwise altered and new ponds or basins to be built.
 - j. Emergency flood routing path(s) and their invert elevations from detention facilities to the receiving system.
 - k. One or more typical cross sections of all existing and proposed channels or other open drainage facilities carried to a point above the 100-year high water and showing the elevation of the existing land and the proposed changes, together with the high water elevations expected from the 100-year storm under the controlled conditions called for by The City of Westfield's applicable stormwater management ordinance(s), and the relationship of structures, streets, and other facilities.
 - l. A drainage summary, which summarizes the basic conditions of the drainage design, including site acreage, off-site/upstream acreage, allowable release rates, post-developed 10-year, and 100-year flows leaving the site, volume of detention required, volume of detention provided, and any release rate restrictions.
 - m. Arrows designating the direction of stormwater runoff.
 - n. Spot elevations appropriate to define elevations.
- vi. Utility plan sheet(s) showing the location of all existing and proposed utility lines for the project, including all available information related to the utilities, such as pipe size and material, and invert elevations. Include plan and profiles of all sanitary and storm infrastructure along with a separate sheet for the water plan.
- vii. Storm sewer plan/profile sheet(s) at a scale of 5 vertical and 50 horizontal showing the elevation, size, length, location of all proposed storm sewers. Existing and proposed ground grades, storm sewer structure elevations, and all existing and proposed utility crossings also must be included. The actual correct datum (not an assumed one) must be used for the profile sheets and all pipe inverts, top of casting elevations, casting types, structure numbers, and pipe slopes clearly labeled.
- viii. A plat on the same sheet size used for recording, including the following information:
- a. Legal description.
 - b. Cross reference to Rule 12.
 - c. Regulated drain statement and table.
- ix. Proposed subdivision landscape plans
- x. A copy of the subdivision covenants
- xi. Any other information required by the WPWD in order to thoroughly evaluate the submitted material.

A written stormwater drainage technical report must contain a discussion of the steps taken in the design of the stormwater drainage system. Note that in order to gain an understanding of and to evaluate the relationship between the proposed improvements for a specific project section/phase and the proposed improvements for an overall multi-section (phased) project, the detailed information requested herein for the first section/phase being permitted must be accompanied by an overall project plan that includes the location, dimensions, and supporting analyses of all detention/retention facilities, primary conveyance facilities, and outlet conditions. The technical report needs to include the following detailed items:

- i. A summary report, including the following information:
 - a. Description of the nature and purpose of the project.
 - b. The significant drainage problems associated with the project.
 - c. The analysis procedure used to evaluate these problems and to propose solutions.
 - d. Any assumptions or special conditions associated with the use of these procedures, especially the hydrologic or hydraulic methods.
 - e. The proposed design of the drainage control system.
 - f. The results of the analysis of the proposed drainage control system showing that it does solve the project's drainage problems and that it meets the requirements of the ordinance and these standards. This must include a table summarizing, for each eventual site outlet, the pre-developed acreage tributary to each eventual site outlet, the unit discharge allowable release rate used, the resulting allowable release rate in cfs for the post-developed 10-year and 100-year events, pre-developed 2-year flow rates in cfs as well as pre- and post-developed flow rates for 10- and 100-year events. The worksheet provided as Table 03102-1 should be filled and submitted as part of the report. Any hydrologic or hydraulic calculations or modeling results must be adequately cited and described in the summary description. If hydrologic or hydraulic models are used, the input and output files for all necessary runs must be included in the appendices. A map showing any drainage area subdivisions used in the analysis must accompany the report.
 - g. Soil properties, characteristics, limitations, and hazards associated with the project site and the measures that will be integrated into the project to overcome or minimize adverse soil conditions.
 - h. A narrative and photographic record of the condition of the downstream receiving system.
 - i. Identification of any other State or Federal water quality permits that are required for construction activities associated with the owner's project site.
 - j. Proof of Errors and Omissions Insurance for the registered professional engineer or licensed surveyor showing a minimum amount of \$1,000,000 in coverage.
- ii. A Hydrologic/Hydraulic Analysis, consistent with the methodologies and calculation included in Chapters 03200 and 03300 of this Manual, and including the following information:
 - a. A hydraulic report detailing existing and proposed drainage patterns on the subject site. The report should include a description of present land use and proposed land use. Any off-site drainage entering the site or any downstream restrictions should be addressed as well. This report should be comprehensive and detail all of the steps the engineer took during the design process.
 - b. All hydrologic and hydraulic computations should be included in the submittal. These calculations should include, but are not limited to the following: runoff curve numbers and runoff coefficients, runoff calculations, stage-discharge relationships, times-of-concentration and storage volumes.

- c. Copies of all computer runs. These computer runs should include both the input and the outputs. Electronic copies of the computer runs with input files must also be included.
- d. A set of exhibits should be included showing the drainage sub-areas and a schematic detailing of how the computer models were set up.
- e. A conclusion which summarizes the hydraulic design and details how this design satisfies the City of Westfield's applicable stormwater management ordinance(s) and these Standards.

03102.05
Stormwater
Pollution
Prevention Plan
for Construction
Sites

A stormwater pollution prevention plan associated with construction activities must be designed to, at least, meet the requirements of the City of Westfield's applicable stormwater management ordinance(s) and must include the following:

- i. Location, dimensions, detailed specifications, and construction details of all temporary and permanent stormwater quality measures.
- ii. Soil map of the predominant soil types, as determined by the United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Soil Survey, or as determined by a soil scientist. Hydrologic classification for soils should be shown when hydrologic methods requiring soils information are used. A soil legend must be included with the soil map.
- iii. 14-Digit Watershed Hydrologic Unit Code. Longitude and latitude location.
- iv. An estimate of the peak discharge, based on the ten (10) year storm 24-hour event, of the project site for post-construction conditions.
- v. Locations where stormwater may be directly discharged into groundwater, such as abandoned wells or sinkholes. Please note if none exists.
- vi. Locations of specific points where stormwater discharge will leave the project site.
- vii. Name of all receiving waters. If the discharge is to a separate MS4, identify the name of the municipal owner and the ultimate receiving water.
- viii. Temporary stabilization plans and sequence of implementation.
- ix. Permanent stabilization plans and sequence of implementation.
- x. Temporary and permanent stabilization plans shall include the following:
 - a. Specifications and application rates for soil amendments and seed mixtures.
 - b. The type and application rate for anchored mulch.
- xi. General construction sequence of how the project site will be built, including phases of construction.
- xii. Construction sequence describing the relationship between implementation of stormwater quality measures and stages of construction activities.
- xiii. Location of all soil stockpiles and borrow areas.
- xiv. A typical erosion and sediment control plan for individual lot development.
- xv. Self-monitoring program including plan and procedures.
- xvi. A description of potential pollutant sources associated with the construction activities, which may reasonably be expected to add a significant amount of pollutants to stormwater discharges.
- xvii. Material handling and storage associated with construction activity shall meet the spill prevention and spill response requirements in 327 IAC 2-6.1.
- xviii. Name, address, telephone number, and list of qualifications of the trained individual in charge of the mandatory stormwater pollution prevention self-monitoring program for the project site.

03102.06
Post-Construction
Stormwater
Pollution
Prevention Plan

The post-construction stormwater pollution prevention plan must include the following information:

- i. A description of potential pollutant sources from the proposed land use, which may reasonably be expected to add a significant amount of pollutants to stormwater discharges.
- ii. Location, dimensions, detailed specifications, and construction details of all post-construction stormwater quality measures.
- iii. A description of measures that will be installed to control pollutants in stormwater discharges that will occur after construction activities have been completed.
- iv. A sequence describing when each post-construction stormwater quality measure will be installed.
- v. Stormwater quality measures that will remove or minimize pollutants from stormwater run-off.
- vi. Stormwater quality measures that will be implemented to prevent or minimize adverse impacts to stream and riparian habitat.
- vii. An operation and maintenance manual for all post-construction stormwater quality measures to facilitate their proper long term function. This operation and maintenance manual shall be in a separate cover and shall be made available to future parties who will assume responsibility for the operation and maintenance of the post-construction stormwater quality measures. The manual shall include the following:
 - a. Contact information for the BMP owner (i.e. name, address, business phone number, cell phone number, pager number, e-mail address, etc.).
 - b. A statement that the BMP owner is responsible for all costs associated with maintaining the BMP.
 - c. A right-of-entry statement allowing the WPWD personnel to inspect and maintain the BMP.
 - d. Specific actions to be taken regarding routine maintenance, remedial maintenance of structural components, and sediment removal. Sediment removal procedures should be explained in both narrative and graphical forms. A tabular schedule should be provided listing all maintenance activities and dates for performing these required maintenance activities.
 - e. Site drawings showing the location of the BMP and access easement, cross sections of BMP features (i.e. pond, forebay(s), structural components, etc.), and the point of discharge for stormwater treated by the BMP.
- viii. Any other information necessary for the review the project if LID Approach is being utilized as discussed in Chapter 03700 of these Standards Manual.

03102.07
Review of
Individual Lots
Within a
Permitted Project

For individual lots disturbing less than 1 acre, developed within a larger permitted project, a formal review and issuance of an Erosion and Sediment Control Inspection Permit Request for Residential Lots and Outlots will be required before a building permit can be issued. All stormwater management measures necessary to comply with the City of Westfield's applicable stormwater management ordinance(s) must be implemented in accordance with permitted plan for the larger project.

The following information must be submitted to the WPWD, for review and acceptance, by the individual lot operator, whether owning the property or acting as the agent of the property owner, as part of a request for review and issuance of an Erosion Control Inspection Permit Request that must be obtained prior to the issuance of a building permit.

- A. The individual lot operator must complete an Erosion Control Inspection Permit Request and pay the applicable fee.
- B. A certified site layout for the subject lot and all adjacent lots showing building pad location, dimensions, and elevations, and the drainage patterns and swales.

- C. Erosion and sediment control plan that, at a minimum, includes the following measures:
 - i. Installation and maintenance of a stable construction site access.
 - ii. Installation and maintenance of appropriate perimeter erosion and sediment control measures prior to land disturbance.
 - iii. Minimization of sediment discharge and tracking from the lot.
 - iv. Clean-up of sediment that is either tracked or washed onto roads. Bulk clearing of sediment shall not include flushing the area with water. Cleared sediment must be redistributed or disposed of in a manner that is in compliance with all applicable statutes and rules.
 - v. Adjacent lots disturbed by an individual lot operator must be repaired and stabilized with temporary or permanent surface stabilization.
 - vi. Self-monitoring program including plan and procedures.
- D. Name, address, telephone number, and list of qualifications of the trained individual in charge of the mandatory stormwater pollution prevention self-monitoring program for the project site.

The individual lot owner is responsible for installation and maintenance of all erosion and sediment control measures until the site is stabilized.

Additionally, the Permittee is responsible for ensuring that a BMP's measures remain in place during the construction process and that the installation and continuous maintenance of all lot erosion and sediment controls, on and/or adjacent to their lots, as well as curb inlets along the street frontage are monitored.

A temporary construction entrance provides a place for parking vehicles off of the street and a spot where material can be off loaded. This requirement is to provide a stable surface for parking vehicles where mud and other debris will not to be tracked onto the street. Proper maintenance of the area is required until such time as a permanent driveway is installed.

Failure to keep streets clear of mud, sediment, and debris will result in an enforcement action by the WPWD under the authority of the City of Westfield's Stormwater Management Ordinance (05-30). The Permittee will be responsible for incurring all costs associated with cleaning the streets.

03102.08
Changes to Plans

Any changes or deviations in the detailed plans and specifications after approval of the applicable stormwater management permit shall be filed with, and accepted by, the WPWD prior to the land development involving the change. Copies of the changes, if accepted, shall be attached to the original plans and specifications.

03102.09
Fee Structure

A. Fee Amount

As a condition of the submittal and the review of development plans by the WPWD, the applicant shall agree to pay the WPWD the applicable fee, as set by the City of Westfield, with respect to the review of all drainage submittals, preliminary plans, final plans, construction plans and accompanying information and data, as well as any applicable pre-paid inspection fees.

B. Time of Payment

Before the WPWD's approval of plans, the WPWD will furnish a written statement to the applicant specifying the total amount due to the WPWD in connection with the review of the applicant's submittals, plans and accompanying information and data, including the amount required to be paid by applicant for review and pre-paid inspection fees.

As a condition of acceptance of final drainage plans by the WPWD, applicant shall pay to the WPWD the sum set forth in said statement. WPWD may issue such a billing statement before the project advances to the final acceptance stage, and such payment is due by applicant upon receipt of said billing statement regardless of whether the project is advanced to the final acceptance stage.

WPWD shall have the right to not accept the drainage improvements or to not accept the advancement of any project for which the applicable fees have not been paid.

C. Method of Payment

Fees shall be paid by one of the following methods:

- Certified Check
- Cashier's Check
- Money Order
- Such other methods as may be agreed in writing by the WPWD

All checks shall be made payable to the City of Westfield.

D. Waiver of Payment

Fees may be waived for certain projects at the discretion of the City of Westfield.

03102.10
N/A

This section intentionally left blank.

03102.11
Permit Terms
and Conditions

In granting a stormwater management permit, WPWD may impose such terms and conditions as are reasonably necessary to meet the purposes of this Ordinance. The project site owner shall insure compliance with such terms and conditions. Non-compliance with the terms and conditions of permits will be subject to enforcement as described in the applicable ordinances.

The project site owner shall inform all general contractors, construction management firms, grading or excavating contractors, utility contractors, and the contractors that have primary oversight on individual building lots of the terms and conditions of the stormwater management permit and the schedule for proposed implementation.

It is the intent of the WPWD to direct the community's physical growth away from sensitive areas and towards areas that can support it without compromising water quality. In the event that a project site is determined to impact or discharge to a Sensitive Area or is located in an Impact Drainage Area, WPWD may require more stringent stormwater quantity and quality measures than detailed in the applicable ordinances or in the latest edition of the Indiana Stormwater Quality Manual.

A. Determination of Sensitive Areas

Sensitive Areas include highly erodible soils, wetlands, threatened or endangered species habitat, outstanding waters, impaired waters, recreational waters, and surface drinking water sources. A listing of highly erodible soils, outstanding water, impaired water, recreation water, and surface drinking water sources can be found in the City of Westfield Storm Water Quality Management Plan (SWQMP) - Part B and its updates. Any discharge from a stormwater practice that is a Class V injection well shall meet the Indiana groundwater quality standards. It is the responsibility of the Developer/Engineer to check if a wetland is present on the project site. If wetlands are suspected on a site, wetland delineation shall be completed in accordance with the methodology established by the U.S. Army Corps of Engineers (COE) and the wetland addressed in accordance to the

requirements of the law. If the presence of threatened or endangered species habitat is suspected on a site, the site must be evaluated and inspected by a professional experienced in such and the results reported to the WPWD. Special terms and conditions for development determined to impact or discharge to any Sensitive Area shall be included in the stormwater management permit.

B. Determination of Impact Drainage Areas

The following areas shall be designated as Impact Drainage Areas, unless good reason for not including them is presented to the WPWD.

- i. A floodway or floodplain as designated by the most updated City of Westfield Code dealing with floodplain regulation.
- ii. Land within 75 feet of each bank of any ditch within the Hamilton County Regulated Drainage System.
- iii. Land within 75 feet of the centerline of any drain tile or enclosed conduit within the Hamilton County Regulated Drainage System.

WPWD is authorized, but is not required, to classify certain additional geographical areas as Impact Drainage Areas. In determining Impact Drainage Areas, WPWD shall consider such factors as land use, topography, soil type, capacity of existing drains, and distance from adequate drainage facility. Land that does not have an adequate outlet, taking into consideration the capacity and depth of the outlet, may be designated as an Impact Drainage Area by the WPWD. Special terms and conditions for development within any Impact Drainage Area shall be included in the stormwater management permit.

SECTION 03103 CONSTRUCTION INSPECTIONS AND APPROVAL

**03103.01
Introduction**

After the approval of the stormwater management permit, WPWD has the authority to conduct inspections of the work being done to ensure full compliance with the provisions of the applicable ordinances and this Manual, and the terms and conditions of the approved permit. The installed storm sewer shall not be accepted by the WPWD until all requirements for inspection and testing described in this Manual are completed. Inspection of the stormwater drainage system and associated land grading and erosion control measures shall be completed by the WPWD as set forth herein to ensure conformance with the approved site construction plan and supporting documents. Any portion of the stormwater facility not passing the tests prescribed herein shall be repaired or replaced to the extent required by the WPWD, and retested.

**03103.02
General
Requirements**

The Contractor and/or Owner shall provide written notice to the WPWD of planned commencement of construction forty-eight (48) hours prior to such commencement. Copies of the final, approved construction plans, stormwater drainage technical report, stormwater pollution prevention plan for construction sites, and post-construction stormwater pollution prevention plan shall also accompany the above-noted written notification. The number of required copies varies from case to case and should be determined by contacting the WPWD.

A pre-construction meeting is required to be held with the participation of the WPWD and other entities involved prior to any grading activity to ensure that appropriate erosion control measures have been implemented on the site and the location of any existing tiles has been properly marked.

A stop-work-order shall be issued by the WPWD for all projects that are proceeding without such notification, pre-construction meeting, or deviation from any of the specifications described herein without approval. WPWD has the authority to conduct inspections of the work being done to ensure full compliance with the provisions of the applicable ordinances and this Manual, and the terms and conditions of the approved permit.

03103.03
Testing

Once constructed, all storm sewer pipes and manholes shall be water tight. All storm and subsurface drains shall be cleaned and televised after ALL underground utilities are installed with a copy on a CD or thumb drive delivered to the WPWD Inspector. The Contractor shall repair to the satisfaction of the WPWD all visible points of possible bedding and/or backfill infiltration into the system. The method of repair shall be per the approval of the WPWD. When necessary, the Contractor shall remove and reconstruct as much of the work as is necessary to obtain a system that passes the minimum tests prescribed herein.

A. Mandrel Test for Plastic Pipes

No sooner than thirty (30) days after installation, all storm water pipe constructed of PVC or HDPE larger than 6 inches in diameter shall be mandrel tested. A representative of the WPWD shall be present on-site during all mandrel tests. WPWD shall be given written notification of the proposed testing times and locations at least 48 hours prior to the intended time for beginning of the tests. Arrangements for the cost and supply of all equipment necessary to perform mandrel tests shall be the responsibility of the Contractor and Owner.

Mandrel tests shall be conducted under the supervision of the WPWD.

A seven and one-half (7-1/2) percent "GO/NO-GO" Mandrel Deflection Test shall be performed on all PVC and HDPE gravity storm sewer pipe. HDPE and PVC gravity storm sewer pipe shall not be permitted for any other use than sub-surface drains unless a special circumstance requires its use as determined and approved by the WPWD.

These pipes shall be mandrel led with a rigid device sized to pass seven and one-half (7-1/2) percent or less deflection (OR deformation) of the base inside diameter of the pipe. The mandrel test shall be conducted no earlier than thirty (30) days after reaching final trench backfill grade.

The mandrel (GO/NO-GO) device shall be cylindrical in shape and constructed with nine (9) or ten (10) evenly spaced arms or prongs. Variations of mandrel diameter dimensions due to pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the diameter dimension of the mandrel but shall be counted as par of the 7-1/2% or lesser deflection allowance. Each pipe material/type required to be Mandrel tested shall be tested with a mandrel approved by the WPWD and meeting the requirements of this chapter. The mandrel diameter dimension shall carry a minimum tolerance of 0.01 inches.

The mandrel shall be hand pulled through all sewer lines and any section of sewer not passing the mandrel shall be uncovered, replaced or repaired, and retested.

The contact length (L) shall be measured between points of contact on the mandrel arm.

The Contractor shall provide proving rings to check the mandrel. Drawings of mandrels with complete dimensions shall be furnished by the Contractor to the WPWD upon request for each diameter and specification of pipe.

B. CMP and RCP Inspections

All reinforced concrete and corrugated metal storm sewer pipes that are 42 inch in diameter or larger shall be inspected through a walk through (visual survey) inspection with the contractor, developer, and a representative from the WPWD.

All reinforced concrete and corrugated metal storm sewer pipes are required to be inspected through closed circuit television viewing (CCTV) at the developer's or contractor's expense by the WPWD's representative as described herein. In those instances where CCTV is a required part of the stormwater permits approval, this televised viewing shall be completed in conformance with these minimum guidelines. The inspection between manholes shall be conducted as follows:

1. A camera equipped with remote control devices to adjust the light intensity and one thousand (1,000) lineal feet of cable shall be provided. The camera shall be able to transmit a continuous image to the television monitor as it is being pulled through the pipe. The image shall be clear enough to enable the WPWD to easily evaluate the interior condition of the pipe. The camera should have a digital display for lineal footage and project number and an audio voice-over shall be made during the inspection identifying any problems. Reference WPWD Standards Section 02750.
2. All pipe, including sub-surface drains, shall be thoroughly cleaned before the camera is installed and televising is commenced. Cleaning of the pipe shall be the responsibility of the owner.
3. The CD – Digital format, as directed by the WPWD, of the entire storm sewer line and reproduction map indicating the pipe segment numbers of all the pipe that has been televised shall be submitted to the department for review and placement in their permanent file. The pipe should be flooded with clear water just prior to video recording to show any bellies or sags in the pipe.

These inspections shall be required in order to identify, as examples, excessive sedimentation, joint failures, excessive deflections (CMP), damaged coatings or paving (CMP), structural defects, misalignments, sags, or other system defects which have the potential of affecting the hydraulic performance, durability, or structural integrity of the line segment. Reference should be made to Chapter 03400 of this manual for guidance on criteria sufficient to warrant rejection of the installed storm sewer system.

Excessive deflection of CMPs shall be considered to exist under the following conditions: variations from a straight centerline; elliptical shape in a pipe intended to be round; dents or bends in the metal. Metallic or bituminous coatings that have been scratched, scraped, bruised, or otherwise broken shall be considered acceptable criteria for rejection of the installed system.

Any pipe and/or joint found to be defective as a result of the televised viewing shall be required to be repaired or replaced to the satisfaction and approval of the WPWD. A re-televising of that portion of the storm sewer line identified as needing repair or replacement shall be required.

C. Manhole and Box Inlet Inspection

Each manhole and/or box inlet structure within all storm sewer line segments shall be visually inspected by a representative of the WPWD prior to backfill to ensure seams are sealed, pipes have concrete collars, and structure is watertight. A secondary inspection by a representative of the WPWD shall be required to check for excessive leakage, backfill infiltration, or improper workmanship and materials. Doghouse structures shall be permitted with approval from the WPWD. Manholes or box inlet structures which fail to

meet minimum construction standards shall be repaired or, if necessary, replaced, and reinspected.

03103.04
Release of
Performance
Sureties

Notice of the scheduled date for completion of construction shall be provided to the WPWD at least seventy-two (72) hours prior to its planned completion. The Contractor or Owner will schedule the final inspection, the storm drain and site grading performance sureties will be released after submittal and approval by the WPWD of the following information (Reference Section 01001):

1. All punch list items are completed and verified by the WPWD.
2. As-built or record drawings prepared under the supervision of and certified by a Professional Engineer or Land Surveyor registered in the State of Indiana, as described in Section 03103.05 of this Manual.
2. For subdivided and platted or developments larger than two (2) acres, a copy of the maintenance bond, as required in Section 03104-01 of this Manual, in a form approved by the City of Westfield.
3. A "Certificate of Completion and Compliance" certifying that the completed storm drainage system and stormwater management facilities substantially comply with construction plans and the stormwater management permit as approved by the WPWD.

That portion of the performance surety associated with the storm sewer system, detention facilities, and Post-Construction BMPs may be released by the WPWD prior to the release of performance surety associated with early permanent site stabilization or the installation of required erosion and sediment control measures for individual lots within a permitted subdivision. The performance surety associated with erosion and sediment control measures may only be released upon the final acceptance of the project and the issuance of the "verified" NOT in accordance with the requirements of Rule 5 (327 IAC 15-5), i.e., upon stabilization of the entire construction site and the removal of temporary erosion and sediment control measures, which may be achieved before or after the construction of all individual lots within a subdivision.

03103.05
As-built or
Record Drawings

As part of the final acceptance process, record drawings of the stormwater facilities must be submitted to the WPWD, as set forth herein, for the following types of developments:

- All platted subdivisions
- Industrial and commercial sites five acres and larger

After completion of construction of the project and before final project acceptance of the stormwater management plan (the issuance of a "verified" NOT), a professionally prepared and certified record drawings ('as-built' set of plans) by a Professional Engineer or licensed Land Surveyor registered in the State of Indiana shall be submitted to the WPWD for review. These as-built plans/record drawings must be prepared and certified by the Engineer of Record, i.e., the company/engineer who originally prepared the construction plans. Additionally, a digital copy of the record drawings ('as-built' plans) as well as finalized digital versions of all analyses, models, manuals, and reports that are consistent with the as-built conditions is required in a format accepted by the WPWD. These plans shall include all pertinent data relevant to the completed storm drainage system and stormwater management facilities, and shall include:

1. Pipe size and pipe material
2. Invert elevations, top of casting elevations, swale flow lines, lot elevations, etc
3. Top rim elevations

4. Pipe structure lengths
5. BMP types, dimensions, and boundaries/easements
6. “As-planned” plans for BMPs, as applicable
7. Data and calculations showing detention basin storage volume
8. Data and calculations showing BMP treatment capacity
9. Certified statement on plans stating the completed storm drainage system and stormwater management facilities substantially comply with construction plans and the stormwater management permits as approved by the WPWD.

In addition, any requirements established by the City of Westfield Digital Submission Standards shall also be met.

03103.06
Enforcement
of Standards

Failure to comply with those minimum guidelines set forth by the manual may result in Enforcement Action per the Storm Water Management Ordinance as well as a Stop-Work order.

SECTION 03104 POST-CONSTRUCTION MAINTENANCE REQUIREMENTS

03104.01
Maintenance
Surety

Stormwater quantity and quality management facilities shall be maintained in good condition, in accordance with the Operation and Maintenance procedures and schedules listed in the latest editions of the Indiana Stormwater Quality Manual or requirements contained in this Manual, and the terms and conditions of the approved stormwater permit, and shall not be subsequently altered, revised, or replaced except in accordance with the approved stormwater permit, or in accordance with approved amendments or revisions in the permit. Following construction completion and before the release of maintenance sureties described below, the maintenance of stormwater quantity or quality facilities may become the long-term responsibility of the owner of the facility.

A table listing the name and location of every post-construction stormwater quality BMPs shall also be included on the recorded plat. A sample table is provided as Table 03104-1.

The property owner, developer, or contractor shall be required to file a three-year maintenance bond or other acceptable guarantee with the City of Westfield, prior to the release of Performance Sureties. Specifically, the said assurance is intended to guarantee that the following be properly maintained after the construction under the provisions of the City of Westfield’s applicable stormwater management ordinance(s) and this Technical Standards:

- Post-Construction Erosion and sediment controls
- Storm sewer system
- Sub-Surface Drains (SSD)
- Detention facilities
- Post-Construction BMPs

The maintenance surety shall further be conditioned upon owner, developer, or contractor satisfactorily completing, within the three-year period following the completion of construction, such corrective actions as the WPWD may determine are reasonably necessary to remedy any damages to upstream or downstream channels or storm sewers resulting from the as-built development of the project.

Bonds or letter of credit are to be made out to the City of Westfield. Said financial maintenance guarantee shall be conditioned upon the following:

1. A sum shall be fixed and approved by the WPWD equal to ten percent (10%) of the actual construction cost of all stormwater management improvements and installations provided in the construction drawings and accompanying data to specifications cited herein. Said costs shall be for the installation and ongoing monitoring and post-construction maintenance of storm drainage infrastructure, detention/retention facilities, and stormwater quality BMPs, as regulated under the City of Westfield's applicable stormwater management ordinance(s) and this Technical Standards. Assurances shall be for a minimum of \$5,000. Reference Section 01001.
2. Each public facility improvement or installation provided in the final plat or accompanying data shall be bonded individually and shall not have the maintenance guarantee provided in combination with any of the other public facility improvements and installations.
3. The maintenance surety shall be issued in the name of the owner, developer, contractor or other responsible party as determined by the WPWD.

03104.02
Post-
Construction
Inspection

The City of Westfield and WPWD has the authority to perform long-term, post-construction inspection of all public or privately owned stormwater quantity and quality facilities. The inspections will follow the Operation and Maintenance procedures included in this Manual and/or permit application for each specific BMP. The inspection will cover physical conditions, available water quantity and quality storage capacity and the operational condition of key facility elements. Noted deficiencies and recommended corrective action will be included in an inspection report. If deficiencies are found during the inspection, the owner of the facility will be notified by the WPWD's Office and will be required to take all necessary measures to correct such deficiencies. If the owner fails to correct the deficiencies within the allowed time period, as specified in the notification letter, the WPWD will undertake the work and collect from the owner using lien rights if necessary.

03104.03
Release of
Maintenance
Sureties

The maintenance surety posted by the developer, owner, or the contractor shall run and be in force for a period of three (3) years from the date of release of the performance surety.

To verify that all enclosed drains are functioning properly, all storm sewer including sub-surface drains are to be cleaned and televised with visual recordings (via closed circuit television) of such tile drains shall be required before release of maintenance sureties. These visual recordings will be scheduled at least 90 days prior to the expiration date of the maintenance bond. Reports summarizing the results of the noted visual recordings shall be reviewed and accepted by the WPWD before maintenance sureties would be recommended to be released.

SECTION 03105 OTHER REQUIREMENTS

03105.01
Floodplain
Management

Floodplain management shall be in accordance with the City of Westfield's adopted floodplain regulations. In addition to these regulations, the following floodplain policy is adopted by the City of Westfield.

The intent of Floodplain management is to protect against loss of property, protect human life, and maintain natural beneficial functions of floodplains in helping mitigate flooding and providing habitat and water quality benefits. Therefore, filling of the land in the floodplain of a regulated drain or any natural stream or watercourse, that has a defined channel and a contributing drainage area of 25 acres or more, located within the land under the jurisdiction of the City of Westfield government is prohibited. The use of the floodplain area for detention/retention ponds or lakes is also prohibited. Floodplain boundaries are to be determined by using the 100-year Base Flood Elevation (BFE) as shown on the Flood Insurance Rate Maps (FIRM) of the Federal Emergency Management Agency (FEMA), or the best available/calculated data if FIRM does not show the BFE and the Hamilton County 1-foot topographic data available on the Hamilton County GIS webpage.

- A. If, during the process of using the BFE and the 1-foot topographic data, it is determined that the FIRM is incorrect, then a Letter of Map Revision (LOMR) to correct the FIRM is to be filed with FEMA. No filling of the floodplain, either the floodplain shown on the FIRM or the floodplain determined by the Floodplain Study, whichever is more conservative, will be allowed until an approved copy of the LOMR is provided to the City of Westfield.
- B. If a FIRM does not establish a 100-year BFE for a regulated drain, natural stream, or natural watercourse, the 100-year BFE shall be established through a site specific Floodplain Study performed by a Professional Engineer registered in the State of Indiana.
 - 1. If the drainage area for the Floodplain Study reach is greater than 1 square mile at the farthest downstream point of the study reach, then the Floodplain Study must be submitted to IDNR – Division of Water for approval and to the WPWD for review and comment. A copy of the final study, approved by IDNR-Division of Water, must be submitted to the WPWD as part of the project requiring the study to be completed. Upon acceptance of the Floodplain Study by IDNR – Division of Water, a Letter of Map Revision (LOMR) is to be filed with FEMA to incorporate the new Floodplain Study into the new FIRM panels.
 - 2. If the drainage area for the Floodplain Study reach is less than 1 square mile at the farthest downstream point of the study reach, then the Floodplain Study must be submitted to the WPWD for review and approval. The methodology for determining the BFE shall be in accordance to Chapters 03200 and 03300 of these Standards. WPWD will have the option to send the Floodplain Study to a consulting engineering firm for review and comment, should the accuracy of the Floodplain Study be in question. The cost of the consulting engineering firm's time will be the responsibility of the owner of the project and will need to be approved in a written agreement prior to any review of the Floodplain Study by the consulting engineer.
- C. The requirements of this section do not apply to the following:
 - 1. Agricultural uses such as crop production, pastures, orchards, tree farms, planting nurseries, vineyards, and general farming.
 - 2. Forestry, wildlife areas and nature preserves.
 - 3. County, City, or Township Parks.
 - 4. Public Streets, bridges, and roadways, as long as the crossing structure are properly sized to convey the natural stream or watercourse and not raise the 100-year BFE.

5. Regional Detention Basins approved by the WPWD. (By definition, a regional pond is a pond that detains all tributary on-site and off-site flows upstream of its outlet.)

D. Regulated Drain Watershed Considerations

If the project site is within a Hamilton County Regulated Drain Watershed, the applicant will also need to abide by the Hamilton County Surveyor's Office applicable floodplain management requirements, whether the site is located in an incorporated area or not.

03105.02
Grading and
Building Pad
Elevations

Maximum yard slopes are 3:1 where soil has been disturbed during construction processes. Finished floor elevation or the lowest building entry elevation must be no less than 6 inches above finished grade around the building. Also, the building's lowest entry elevation that is adjacent to and facing a road shall be a minimum of 15 inches above the road elevation.

All buildings shall have a minimum flood protection grade shown on the secondary plat. Minimum Flood Protection Grade of all structures fronting a pond or open ditch shall be no less than 2 feet above any adjacent 100-year local or regional flood elevations, whichever is greater, for all windows, doors, attached garage entrances, unsealed pipe entrances, window well rim elevations, and any other structure member where floodwaters can enter a building.

For all structures located in the Special Flood Hazards Area (SFHA) as shown on the FEMA maps, the lowest floor elevations of all residential, commercial, or industrial buildings shall be such that Lowest Floor elevation, including basement, shall be at the flood protection grade and therefore have 2 feet of freeboard above the 100-year flood elevation.

The Lowest Adjacent Grade for residential, commercial, or industrial buildings outside a FEMA or IDNR designated floodplain shall have 2 feet of freeboard above any applicable local or regional flooding sources' 100-year flood elevation under proposed conditions, whichever is greater. Lowest Adjacent Grade is the elevation of the lowest grade adjacent to a structure, where the soil meets the foundation around the outside of the structure (including structural members such as basement walkout, attached garage door entrance, patios, decks, porches, support posts or piers, and rim of the window well).

For areas outside a FEMA or IDNR designated floodplain, the Lowest Adjacent Grade (including walkout basement floor elevation) for all residential, commercial, or industrial buildings adjacent to ponds shall be set a minimum of 2 feet above the 100-year pond elevation or 2 feet above the emergency overflow weir elevation, whichever is higher. In addition to the Lowest Adjacent Grade requirements, any basement floor must be at least a foot above the permanent water level (normal pool elevation).

Special considerations, based on detailed geotechnical analysis, should be made prior to considering placement of any basement below the 100-year flood elevation of an adjacent flooding source or pond.

The LAG requirements for buildings adjacent to overflow path/ponding areas are discussed in Section 03303.07 of this Manual. In case there are more than one flooding sources applicable to a building site, the highest calculated LAG for the building shall govern the placement of the building on that site.

03105.03
Policy on
Dams and
Levees

Dams and levees have the potential for significant, sometimes catastrophic consequences should they fail. In order to minimize the potential for loss of life and public safety, decrease the potential for increased flood damage and disaster costs, and safeguard the downstream property rights, the following shall be required by the HCSO for any proposed new or improvements to any existing

dam or levee. These requirements are in addition to what is normally required for other development subject to this Ordinance and/or that required by State or Federal agencies.

- A. Design of dams shall follow the requirements of the latest edition of IDNR-Division of Water "General Guidelines for New Dams and Improvements to Existing Dams in Indiana" as well as principles provided in the latest edition of "Indiana Dam Safety Inspection Manual".
- B. Design of levee/floodwalls shall follow the FEMA requirements and guidelines provided in 44 CFR Section 65.10 and USACE Engineer Manual 1110-2-193, Design and Construction of Levees.
- C. An Emergency Action Plan (EAP), including a detailed dam breach inundation map, shall be developed in accordance with the template provided in the latest edition of "Indiana Dam Safety Inspection Manual" and submitted to the HCSO. The detailed dam breach inundation map referenced in this paragraph shall be developed for both "Sunny Day Breach" Scenario (breach during normal loading conditions) and for maximum loading condition with breach assumed to occur as the spillway system is passing the Spillway Design Flood associated with the dam ("SDF + Breach" Scenario).
- D. Unless the "Sunny Day Breach Inundation Area" is entirely contained within the applicant's property and/ or contained within the existing 1% annual chance (100-year) floodplain, a copy of recorded flood/inundation easement or a recorded written consent for every property within the potential "Sunny Day Breach Inundation Area" shall be submitted to the HCSO. In addition, all the affected property owners whose properties are located within the "SDF + Breach Inundation Area" must be notified of a hearing relevant to the proposed added risk. Notification of the time and place of the hearing shall be made in person or by certified mail at least five (5) to ten (10) days prior to the hearing. Proof of notice to each landowner shall be filed by affidavit with the HCSO prior to the hearing.
- E. A copy of a Management and Maintenance Plan for the proposed dam or levee developed in accordance with the latest edition of "Indiana Dam Safety Inspection Manual" shall be submitted to the HCSO.
- F. Following the permitting and construction of the dam or levee, a copy of a formal periodic inspection report prepared in accordance with the recommendations contained in the latest edition of "Indiana Dam Safety Inspection Manual" shall be submitted to the HCSO along with evidence that the identified maintenance deficiencies have been corrected. The inspection report has to be submitted as it gets completed in accordance with the inspection frequency recommended in the latest edition of "Indiana Dam Safety Inspection Manual".

SITE OUTLET #	ITEM	PRE-DEVELOPMENT					POST-DEVELOPMENT				
		D.A. (ac)	Depress. Storage? (yes/no)	2- Yr.	10- Yr.	100- Yr.	D.A. (ac)	Depress. Storage? (yes/no)	2- Yr.	10- Yr.	100- Yr.
1	Default Unit Discharge Allowable Release Rate (cfs/acre)									0.1	0.3
	Basin-Specific Unit Discharge Allowable Release Rate, if any (cfs/acre)										
	Unit Discharge Allowable Release Rate Based on D/S Restrictions, if any (cfs/acre)										
	Adopted Unit Discharge Allowable Release Rate (cfs/acre)										
	Contributing Area of Development Site (ac) and Allowable Release Rate (cfs)										
	Total Contributing DA (ac) and Modeling Results (cfs)							no			

Table 03102-1: Allowable Release rate Determination and Modeling Results

Structure Number	BMP Name	BMP Description	BMP Location

Table 03104-1: Listing of Post-Construction Stormwater Quality BMPs Proposed to be Accepted as Part of Hamilton County Regulated Drainage System

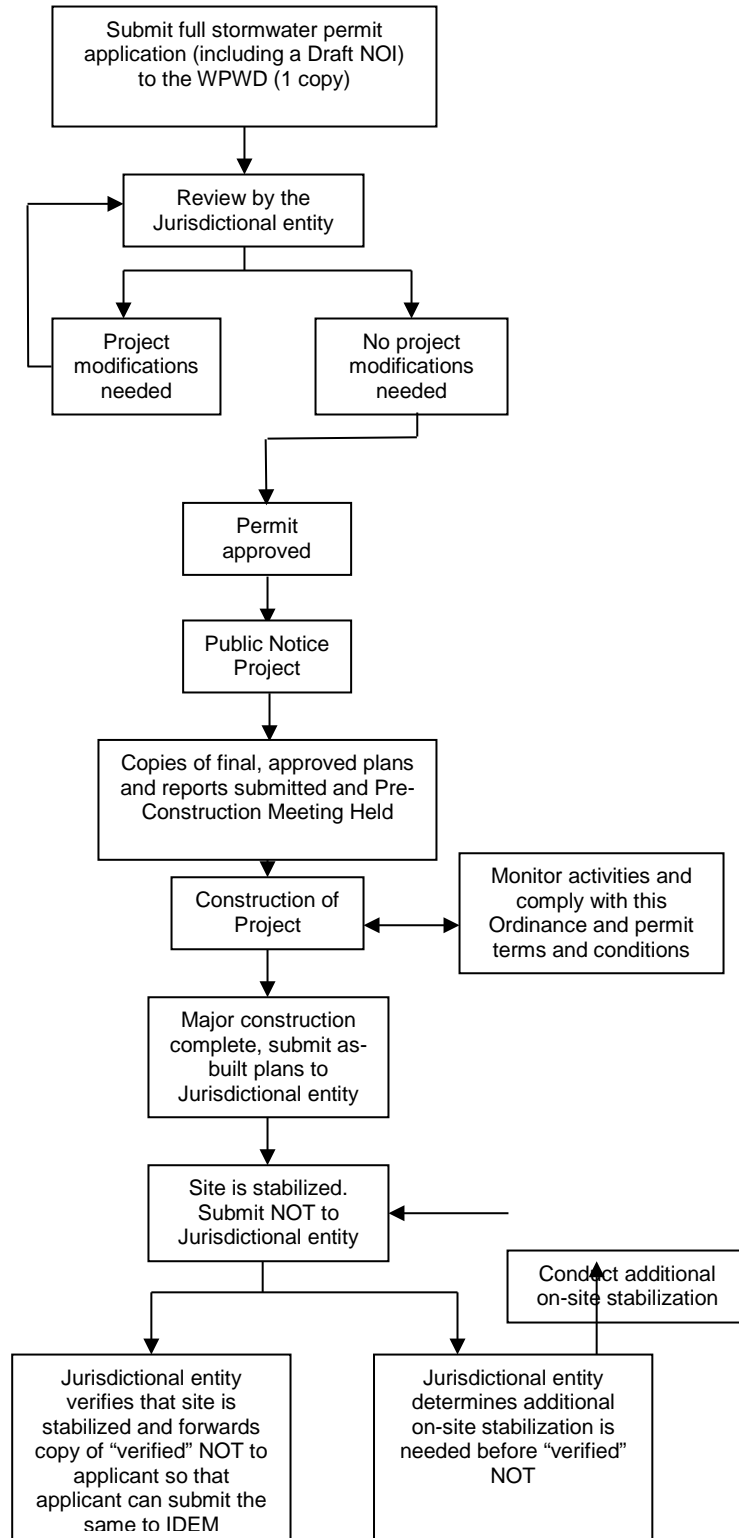


Exhibit 03102-1: Flow Chart of the Stormwater Plan Review/Permit Process

CHAPTER 03200 HYDROLOGY

SECTION 03201 BASIC POLICIES AND REQUIREMENTS

The following section provides a list of design policies which must be applied during a hydrologic analysis performed within the City of Westfield jurisdictional area.

03201.01 Abbreviations and Definitions

Following are discussions of concepts which will be important in a hydrologic analysis. These concepts will be used throughout the remainder of this chapter in dealing with different aspects of hydrologic studies.

Abbreviations

COE:	United States Army Corps of Engineers
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IDEM:	Indiana Department of Environmental Management
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IDNR:	Indiana Department of Natural Resources
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INDOT:	Indiana Department of Transportation
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NRCS:	USDA-Natural Resources Conservation Service
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USDA:	United States Department of Agriculture
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Definitions

Antecedent Moisture Condition:	The index of runoff potential before a storm event. The index, developed by the Natural Resource Conservation Service (NRCS), is an attempt to account for the variation of the NRCS runoff curve number (CN) from storm to storm.
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Catch Basin:	A chamber usually built at the curb line of a street for the admission of surface water to a storm drain or subdrain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.
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Channel:	A portion of a natural or artificial watercourse which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. It has a defined bed and banks which serve to confine the water.
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Culvert:	A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal or other impediment.
Curve Number:	The NRCS index that represents the combined hydrologic effect of soil, land use, land cover, hydrologic condition and antecedent runoff condition.
Depression Storage:	Non-riverine depressions in the earth where stormwater collects. The volumes are often referred to in units of acre-feet.
Design Storm:	A selected storm event, described in terms of the probability of occurring once within a given number of years, for which drainage or flood control improvements are designed and built.
Drainage Area:	The area draining into a stream at a given point. It may be of different sizes for surface runoff, subsurface flow and base flow, but generally the surface runoff area is considered as the drainage area.
Duration:	The time period of a rainfall event.
Hydrograph:	For a given point on a stream, drainage basin, or a lake, a graph showing either the discharge, stage (depth), velocity, or volume of water with respect to time.
Infiltration:	Passage or movement of water into the soil.
Inlet:	An opening into a storm drain system for the entrance of surface storm water runoff, more completely described as a storm drain inlet.
Major Drainage System:	Drainage system carrying runoff from an area of one or more square miles.
Minor Drainage System:	Drainage system carrying runoff from an area of less than one square mile.
Peak Discharge:	The maximum instantaneous flow from a given storm condition at a specific location.
Rainfall Intensity:	The rate at which rain is falling at any given instant, usually expressed in inches per hour.
Runoff:	That portion of precipitation that flows from a drainage area on the land surface, in open channels, or in stormwater conveyance systems.

Storm Frequency:	The time interval between major storms of predetermined intensity and volumes of runoff (e.g. a 5-yr., 10-yr., or 20-yr. storm).
Storm Sewer:	A closed conduit for conveying collected storm water, while excluding sewage and industrial wastes. Also called a storm drain.
Swale:	An elongated depression in the land surface that is at least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and may provide some groundwater recharge.
Time of Concentration:	The travel time of a particle of water from the most hydraulically remote point in the contributing area to the point under study. This can be considered the sum of an overland flow time and times of travel in street gutters, storm sewers, drainage channels, and all other drainage ways.
Watercourse:	Any river, stream, creek, brook, branch, natural or man-made drainageway in or into which stormwater runoff or floodwaters flow either continuously or intermittently.
Watershed:	The region drained by or contributing water to a specific point that could be along a stream, lake or other stormwater facilities. Watersheds are often broken down into subareas for the purpose of hydrologic modeling.
Symbol Table:	To provide consistency within this chapter as well as throughout this manual the following symbols will be used. These symbols were selected because of their wide use in hydrologic publications. In some cases the same symbol is used in existing publications for more than one definition. Where this occurs in this chapter, the symbol will be defined where it occurs in the text or equations.

<u>Symbols</u>	<u>Definition</u>	<u>Units</u>
A	Drainage Area	acres
C	Runoff Coefficient	-
CN	NRCS-runoff curve number	-
D	Duration	hours
I	Rainfall intensity	in/hr
n	Manning roughness coefficient	-
Q	Rate of runoff	cfs
q _p	Peak rate of discharge	cfs
t _c or T _c	Time of concentration	min
V	Velocity	ft/s

Runoff rates shall be computed for the area of the parcel under development plus the area of the watershed flowing into the parcel under development. The rate of runoff which is generated as the result of a given rainfall intensity may be calculated as follows:

A. Development Sites Less than or Equal to 5 Acres in Size, With a Contributing Drainage Area Less than or Equal to 50 Acres and No Depressional Storage

The Rational Method may be used. A computer model, such as TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE), that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies may also be used along with a 24-hour duration NRCS Type 2 storm. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

LID Exception: If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 03700 (Post-Construction Stormwater Quality Management), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 03700 and BMP Fact Sheets may be determined based on pre-development underlying soil layer.

In the Rational Method, the peak rate of runoff, Q , in cubic feet per second (cfs) is computed as:

$$Q = CIA$$

Where: C = Runoff coefficient, representing the characteristics of the drainage area and defined as the ratio of runoff to rainfall.

I = Average intensity of rainfall in inches per hour for a duration equal to the time of concentration (t_c) for a selected rainfall frequency.

A = Tributary drainage area in acres.

Values for the runoff coefficient " C " are provided in Table 03201-1, which shows values for different types of surfaces and local soil characteristics. The composite " C " value used for a given drainage area with various surface types shall be the weighted average value for the total area calculated from a breakdown of individual areas having different surface types.

Rainfall intensity shall be determined from the rainfall frequency data shown in Table 03201-2.

In general, the time of concentration (t_c) methodology to be used for all stormwater management projects within the City of Westfield jurisdictional area shall be as outlined in the U.S. Department of Agriculture (USDA) - NRCS TR-55 Manual. In urban or developed areas, the methodology to be used shall be the sum of the inlet time and flow time in the stormwater facility from the most remote part of the drainage area to the point under consideration. The flow time in the storm sewers may be estimated by the distance in feet divided by velocity of flow in feet per second. The velocity shall be determined by the Manning's Equation (see Chapter 03300). Inlet time is the combined time required for the runoff to reach the inlet of the storm sewer. It includes overland flow time and flow time through established surface drainage channels such as swales, ditches, and sheet flow across such areas as lawns, fields, and other graded surfaces.

B. Development Sites Greater Than 5 Acres in Size or Contributing Drainage Area Greater than 50 Acres or With Significant Depressional Storage

The runoff rate for these development sites and contributing drainage areas shall be determined by a computer model that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies and the 24-hour NRCS Type 2 Rainfall Distribution. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

LID Exception: If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 03700 (Post-Construction Stormwater Quality Management), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 03700 and BMP Fact Sheets may be determined based on pre-development underlying soil layer.

The 24-hour Rainfall depth for various frequencies shall be taken from Table 03201-3. The NRCS Type 2 distribution ordinates are found in Table 03201-4. Examples of computer models that can generate such hydrographs include TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE). These programs may be downloaded free of charge from the associated agencies' web sites. The computer models ICPR and Pond Pack may also be used. However, the latter computer software is proprietary. If interconnected ponds are utilized, the use of ICPR or Pond Pack may be required to appropriately model the more complex hydrologic and hydraulic relationships associated with such system. Other models may be acceptable and should be accepted by the WPWD prior to their utilization.

C. Development Sites with Drainage Areas Greater than or Equal to One Square Mile

For the design of any major drainage system, as defined in Section 03201.01, the discharge must be obtained from, or be accepted by, the IDNR. Other portions of the site must use the discharge methodology in the applicable section of this Chapter.

03201.03 Design Storm Frequencies

The design storm frequency is the basis for all runoff computations and stormwater facility designs. All stormwater facilities, whether private or public, and whether constructed on private or public property, shall conform to the design standards and other requirements contained herein.

1. All storm sewers, inlets, catch basins, and street gutters shall accommodate (subject to the "allowable spread" provisions discussed later in this Section), as a minimum, peak runoff from a 10-year return frequency storm calculated based on methodology described in Section 03201.02. Any upstream, off-site runoff being bypassed through the development's storm sewer system must be accommodated for the 10-year event, with overland flow path provisions considered for bypassing flows in excess of the 100-year event. Additional discharges to storm sewer systems allowed in Section 03501.06 must also be considered in all design calculations. For Rational Method analysis, the duration shall be equal to the time of concentration for the drainage area. In computer based analysis, the duration is as noted in the applicable methodology associated with the computer program.

2. Primary, secondary, and collector street culverts and bridges as noted by the City of Westfield Thoroughfare Plan shall be capable of accommodating, without overtopping the road, peak runoff from a 100-year frequency storm when crossing under a road. All other roadway culverts shall be designed for 50-year frequency storm without overtopping. Bridges that meet the above threshold shall also have a minimum of 2 feet of freeboard below the low chord (lowest structural member) of the bridge structure for the design 100-year flood.
3. For portions of the system considered minor drainage systems, the allowable spread of water on Collector Streets is limited to maintaining two clear 10-foot moving lanes of traffic. One lane is to be maintained on local roads, while other access lanes (such as a subdivision cul-de-sac) can have a water spread equal to one-half of their total width.
4. To ensure access to buildings and allow the use of the roadway by emergency vehicles during storms larger than the design storm, an overflow channel/swale between sag inlets and overflow paths or basin shall be provided at sag inlets so that the maximum depth of water that might be ponded in the street sag shall not exceed 7 inches measured from elevation of gutter.
5. Stormwater facilities functioning as a major drainage system as defined in Section 03201.01 must also meet IDNR design standards in addition to the City of Westfield Public Works Department Standards and Specifications. In case of discrepancy, the most restrictive requirements shall apply.
6. All channels and swales shall accommodate, as a minimum, peak runoff from a 10-year return frequency storm calculated based on methodology described in Section 03201.02. For Rational Method analysis, the storm duration shall be equal to the time of concentration for the drainage area. In computer-based analysis, the duration is as noted in the applicable methodology associated with the computer program.
7. Channels with a carrying capacity of more than 30 cfs at bank-full stage shall be capable of accommodating peak runoff for a 50-year return frequency storm within the drainage easement.
8. The 10-year storm design flow for residential rear and side lot swales shall not exceed 4 cfs. The maximum length of rear and side lot swales before reaching any inlet shall not exceed 3 residential lots or 300 feet, whichever is shorter, unless designed as a stormwater quality BMP that meets the design criteria provided in Chapter 03700.
9. Regardless of minimum design frequencies stated above, the performance of all parts of drainage system shall be checked for the 100-year flow conditions to insure that all buildings are properly located outside the 100-year flood boundary and that flow paths are confined to designated areas with sufficient easement.

TYPE OF SURFACERUNOFF COEFFICIENT ©Non-Urban Areas

Bare earth	0.55
Steep grassed areas (slope 2:1)	0.60
Turf meadows	0.25
Forested areas	0.20
Cultivated fields	0.30

Urban Areas

All watertight roof surfaces	0.90
Pavement	0.85
Gravel	0.85
Impervious soils (heavy)	0.55
Impervious soils (with turf)	0.45
Slightly pervious soil	0.25
Slightly pervious soil (with turf)	0.20
Moderately pervious soil	0.15
Moderately pervious soil (with turf)	0.10
Business, Commercial & Industrial	0.85
Apartments & Townhouses	0.70
Schools & Churches	0.55
Single Family Lots < 10,000 SF	0.45
Lots < 12,000 SF	0.45
Lots < 17,000 SF	0.40
Lots > ½ acre	0.35
Park, Cemetery or Unimproved Area	0.30

TABLE 03201-1: Runoff Coefficients © for Use in the Rational Method

Rainfall Intensities for Various Return Periods and Storm Durations							
Duration	Intensity (Inches/Hour)						
	Return Period (Years)						
	1	2	5	10	25	50	100
5 min	5.09	6.02	7.14	8.09	9.26	10.26	11.2
10 min	3.95	4.7	5.54	6.24	7.09	7.78	8.42
15 min	3.23	3.83	4.54	5.12	5.84	6.42	6.98
30 min	2.14	2.56	3.11	3.55	4.12	4.59	5.04
1 hr	1.3	1.57	1.95	2.26	2.67	3.02	3.37
2 hr	0.76	0.92	1.15	1.34	1.6	1.82	2.05
3 hr	0.54	0.65	0.81	0.95	1.14	1.3	1.47
6 hr	0.32	0.39	0.48	0.56	0.68	0.78	0.88
12 hr	0.19	0.22	0.28	0.32	0.38	0.43	0.49
24 hr	0.11	0.13	0.16	0.18	0.21	0.23	0.26

Source: NOAA, National Weather Service, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 2, 2004, for Fishers, Indiana. (Partial Duration series, upper 90% Confidence Interval, values for intermediate durations can be logarithmically interpolated.)

TABLE 03201-2: Rainfall Intensities for Various Return Periods and Storm Durations

Rainfall Depths for Various Return Periods							
Duration	Depth (Inches)						
	Return Period (Years)						
	1	2	5	10	25	50	100
24 Hrs.	2.54	3.05	3.75	4.29	5.04	5.62	6.22

Source: NOAA, National Weather Service, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 2, 2004, for Fishers, Indiana. (Partial Duration series, upper 90% Confidence Interval).

TABLE 03201-3: Rainfall Depths for Various Return Periods

Cumulative Percent of Storm Time	Cumulative Percent of Storm Depth	Cumulative Percent of Storm Time	Cumulative Percent of Storm Depth
0	0	52	73
4	1	53	75
10	2.5	54	77
15	4	55	78
20	6	56	80
25	8	57	81
30	10	58	82
33	12	60	83.5
35	13	63	86
38	15	65	87
40	16.5	67	88
42	19	70	89.5
43	20	72	91
44	21	75	92
45	22	77	93
46	23	80	94
47	26	83	95
48	30	85	96
48.5	34	87	97
48.7	37	90	98
49	50	95	99
50	64	100	100
51	71		

**TABLE 03201-4: NRCS Type 2 Rainfall Distribution Ordinates
(for use when not already built in the computer program)**

CHAPTER 03300 HYDRAULICS AND HYDRAULIC STRUCTURES

SECTION 03301 INTRODUCTION

This chapter provides policies and technical procedures for analyzing the majority of stormwater facilities required for land alteration projects. However, more detailed analyses may be required depending on the specific site characteristics. Also, a set of Standard Details are available through WPWD or on the City of Westfield's website at www.westfield.in.gov that provides guidance on the design of various hydraulic structures that may not have been covered in this chapter. Adherence to the noted standard details shall be required in addition to other requirements in this chapter. In case of discrepancy, the most restrictive requirement shall apply.

03301.01
Abbreviations and
Definitions

Abbreviations

BMP:	Best Management Practice
COE:	United States Army Corps of Engineers
IDEM:	Indiana Department of Environmental Management
IDNR:	Indiana Department of Natural Resources
INDOT:	Indiana Department of Transportation
NRCS:	USDA-Natural Resources Conservation Service (formerly SCS)
USDA:	United States Department of Agriculture

Definitions

Antecedent Moisture Condition:	The index of runoff potential before a storm event. The index, developed by the Natural Resource Conservation Service (NRCS), is an attempt to account for the variation of the NRCS runoff curve number (CN) from storm to storm.
Catch Basin:	A chamber usually built at the curb line of a street for the admission of surface water to a storm drain or subdrain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.
Channel:	A portion of a natural or artificial watercourse which periodically or continuously contains moving water, or which forms a connecting link

	between two bodies of water. It has a defined bed and banks which serve to confine the water.
Culvert:	A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal or other impediment.
Curve Number:	The NRCS index that represents the combined hydrologic effect of soil, land use, land cover, hydrologic condition and antecedent runoff condition.
Depression Storage:	Non-riverine depressions in the earth where stormwater collects. The volumes are often referred to in units of acre-feet.
Design Storm:	A selected storm event, described in terms of the probability of occurring once within a given number of years, for which drainage or flood control improvements are designed and built.
Drainage Area:	The area draining into a stream at a given point. It may be of different sizes for surface runoff, subsurface flow and base flow, but generally the surface runoff area is considered as the drainage area.
Dry-bottom Detention Basin:	A basin designed to be completely dewatered after having provided its planned detention of runoff during a storm event.
Duration:	The time period of a rainfall event.
Hydrograph:	For a given point on a stream, drainage basin, or a lake, a graph showing either the discharge, stage (depth), velocity, or volume of water with respect to time.
Infiltration:	Passage or movement of water into the soil.
Inlet:	An opening into a storm drain system for the entrance of surface storm water runoff, more completely described as a storm drain inlet.
Lowest Adjacent Grade:	The elevation of the lowest grade adjacent to a structure, where the soil meets the foundation around the outside of the structure (including structural members such as basement walkout, patios, decks, porches, support posts or piers, and rim of the window well).
Major Drainage System:	Drainage system carrying runoff from an area of one or more square miles.
Minor Drainage	Drainage system carrying runoff from an area of less than one square

System:	mile.
Peak Discharge:	The maximum instantaneous flow from a given storm condition at a specific location.
Rainfall Intensity:	The rate at which rain is falling at any given instant, usually expressed in inches per hour.
Regulated Drain:	A drain subject to the provisions of the Indiana Drainage Code, I.C.-36-9-27.
Runoff:	That portion of precipitation that flows from a drainage area on the land surface, in open channels, or in stormwater conveyance systems.
Storm Frequency:	The time interval between major storms of predetermined intensity and volumes of runoff (e.g. a 5-yr., 10-yr., or 20-yr. storm).
Storm Sewer:	A closed conduit for conveying collected storm water, while excluding sewage and industrial wastes. Also called a storm drain.
Stormwater Drainage System:	All means, natural or man-made, used for conducting storm water to, through or from a drainage area to any of the following: conduits and appurtenant features, canals, channels, ditches, storage facilities, swales, streams, culverts, streets and pumping stations.
Stormwater Facility:	All ditches, channels, conduits, levees, ponds, natural and manmade impoundments, wetlands, tiles, swales, sewers and other natural or artificial means of draining surface and subsurface water from land.
Swale:	An elongated depression in the land surface that is at least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and may provide some groundwater recharge.
Storage:	Any structural BMP intended to store or detain stormwater and slowly release it to receiving waters or drainage systems. The term includes detention and retention basins.
Tailwater:	The water surface elevation at the downstream side of a hydraulic structure (i.e. culvert, bridge, weir, dam, etc.).
Time of	The travel time of a particle of water from the most hydraulically

Concentration:	remote point in the contributing area to the point under study. This can be considered the sum of an overland flow time and times of travel in street gutters, storm sewers, drainage channels, and all other drainage ways.
Watercourse:	Any river, stream, creek, brook, branch, natural or man-made drainageway in or into which stormwater runoff or floodwaters flow either continuously or intermittently.
Watershed:	The region drained by or contributing water to a specific point that could be along a stream, lake or other stormwater facilities. Watersheds are often broken down into subareas for the purpose of hydrologic modeling.
Wet-bottom Detention Basin:	Also referred to as a “Retention Basin”, is a basin designed to retain a permanent pool of water after having provided its planned detention of runoff during a storm event.

To provide consistency within this chapter the following symbols will be used. These symbols were selected because of their wide use in hydrologic and hydraulic publications. In some cases the same symbol is used in existing publications for more than one definition. Where this occurs in this chapter, the symbol will be defined where it occurs in the text or equations.

TABLE 03301:1: Symbols and Definitions

<u>Symbols</u>	<u>Definition</u>	<u>Units</u>
A	Drainage area	acres
C	Runoff Coefficient	-
CN	NRCS-runoff curve number	-
D	Duration	hours
I	Rainfall intensity	in/hr
N	Manning roughness coefficient	-
Q	Rate of runoff	cfs
q _p	Peak rate of discharge	cfs
t _c or T _c	Time of concentration	min
V	Velocity	ft/s

SECTION 03302 STORMWATER DETENTION DESIGN FOR PEAK FLOW CONTROL

The following shall govern the design of any improvement with respect to the detention of stormwater runoff for peak flow control. Basins shall be constructed to temporarily detain the stormwater runoff that exceeds the maximum peak release rate authorized by the Ordinance and these Technical standards. The required volume of storage provided in these basins, together with such storage as may be authorized in other on-site facilities, shall be sufficient to control excess runoff from the 10-year or 100-year storm as explained below in Sections 03302.02 and 03302.03. Also, basins shall be constructed to provide adequate capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings.

In addition to the requirement for peak flow control through detention, the Stormwater Management Ordinance and Technical Standards require the developer to address Channel Protection and Water Quality Control requirements discussed in Chapter 03700. The proper way to accommodate the water quality, channel protection, and peak flow rate control of a site is to first consider addressing the water quality and channel protection volume requirements through conventional or LID approaches (as described in Chapter 03700) and then add in the required detention storage for peak flow rate control to the overall site design. Meeting the channel protection/water quality volume requirements, either using Conventional or LID Approaches, often include providing extended detention storage features that are usually combined with the detention storage needed for peak runoff rate control of the site into one facility. The following is the required calculation sequence for designing a detention pond with a combined extended detention and peak flow control detention functions. These steps should be followed carefully to avoid potential future rework.

1. Calculate the required extended detention storage volume as needed to address the Channel Protection Volume (CPv) through the methodology provided in Chapter 03700 (depending on the approach utilized, there may be no need for providing an extended detention storage).
2. Determine the control elevation/invert for the drain serving the proposed extended detention storage (ensuring a positive drain to the site outlet). This will be the elevation of the bottom of the proposed extended detention storage and top of the permanent pool if a wet bottom pond is being provided for.
3. Design a storage space to accommodate the extended detention storage volume determined in Step 1, assuming 0.0 cfs going through the drain that will serve this extended detention storage volume. The top of this storage space will be the bottom of the peak flow rate control detention storage and the invert of the main outlet of this peak flow rate control detention storage.
4. Design the main outlet of the peak flow rate control detention storage, sized to carry the allowable 10-year and 100-year release rates, with its control elevation/invert at the top of the extended detention storage space. For storage space calculation purposes, use the actual orifice size calculated to accommodate the release rates regardless of whether the orifice size is smaller or larger than the minimum orifice size allowed under the Ordinance or Technical Standards.
5. Design the peak flow rate control detention storage space by routing the 10-year and 100-year inflow hydrographs through the pond, assuming the pond is empty to the control elevation of the extended detention storage drain as determined in Step 2, but still assuming 0.0 cfs can get out of the extended detention storage drain as the pond fills up. The resulting maximum water surface elevation is the 100-year pool elevation, where the invert of the emergency overflow weir (sized for 1.25 times the peak inflow rate) is located. The pond size and control elevation/invert elevations are final at this stage.
6. Determine the size of the extended detention storage drain and design the drain system in a manner to meet the extended detention minimum and maximum emptying time requirements discussed in Chapter 03700. Due to typically required clog-free design and maintenance of the extended detention storage drain structures, the minimum orifice size requirements do not apply to these drain structures.
7. To make sure that the addition of the release through the drain will not cause the allowable release rate to be exceeded, reroute the 10-year and 100-year inflow

hydrographs through the pond, this time allowing water to also leave through the extended detention storage drain as the pond fills up. If the total peak outflow discharge exceeds the allowable release rate, reduce the size of the main outlet orifice accordingly (but do not go back to redesign the storage space).

8. If the calculated orifice size of the main peak flow rate control storage outlet is less than the minimum orifice size allowed in the Ordinance or these Technical Standards, designate the minimum orifice size on the construction plans, but do not go back and recalculate/redesign the storage spaces.

03302.01
Acceptable
Detention Facilities

The increased stormwater runoff resulting from a proposed development should be detained on-site by the provisions of appropriate wet bottom or dry bottom detention facilities, parking lots, or other acceptable techniques. Measures that retard the rate of overland flow and the velocity in runoff channels shall also be used to partially control runoff rates.

03302.02
Allowable Release
Rates

General Release Rates

Control devices shall limit the discharge to a rate such that the post-developed release rate from the site is no greater than 0.1 cfs per acre of development for 0 to 10 year return interval storms and 0.3 cfs per acre of developed area for 11 to 100 year return interval storms. The above fixed general release rates may be set at a lower value by the WPWD for certain watersheds if more detailed data becomes available as a result of comprehensive watershed studies conducted and/or formally approved and adopted by the WPWD. The applicant shall confirm the applicable release rates with the WPWD prior to initiating the design calculations to determine whether a basin-specific rate has been established for the watershed.

For sites where the pre-developed area has more than one (1) outlet, the release rate should be computed based on pre-developed discharge to each outlet point. The computed release rate for each outlet point shall not be exceeded at the respective outlet point even if the post developed conditions would involve a different arrangement of outlet points.

Site-Specific Release Rates for Sites with Depressional Storage

For sites where depressional storage exists, the general release rates provided above may have to be further reduced. If depressional storage exists at the site, site-specific release rates must be calculated according to methodology described in Chapter 03200, accounting for the depressional storage by modeling it as a pond whose outlet is a weir at an elevation that stormwater can currently overflow the depressional storage area. Post developed release rate for sites with depressional storage shall be the 2-year pre-developed peak runoff rate for the post-developed 10-year storm and 10-year pre-developed peak runoff rate for the post-developed 100-year storm. In no case shall the calculated site-specific release rates be larger than general release rates provided above.

Note that by definition, the depressional storage does not have a direct gravity outlet but if in agricultural production, it is more than likely drained by a tile and should be modeled as “empty” at the beginning of a storm. The function of any existing depressional storage should be modeled using an event hydrograph model to determine the volume of storage that exists and its effect on the existing site release rate. To prepare such a model, certain information must be obtained, including delineating the tributary drainage area, the stage-storage relationship and discharge-rating curve, and identifying the capacity and elevation of the outlet(s).

The tributary area should be delineated on the best available topographic data. After determining the tributary area, a hydrologic analysis of the watershed should be performed, including, but not limited to, a calculation of the appropriate composite runoff curve

number and time of concentration. Stage-storage data for the depressional area should be obtained from the site topography. The outlet should be clearly marked and any calculations performed to create a stage-discharge rating curve must be included with the stormwater submittal.

Also note that for determining the post-developed peak runoff rates, the depressional storage must be assumed to be filled unless the WPWD can be assured, through a dedicated easement, that the noted storage will be preserved in perpetuity.

Downstream Restrictions

In the event the downstream receiving channel or storm sewer system is inadequate to accommodate the post-developed release rate provided above, then the allowable release rate may need to be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system. Additional detention, as determined by the WPWD, may be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways. When such downstream restrictions are suspected, WPWD may require additional analysis to determine the receiving system's limiting downstream capacity.

If the proposed development makes up only a portion of the undeveloped watershed upstream of the limiting restriction, the allowable release rate for the development shall be in direct proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.

As an alternative, off-site drainage improvements may be required. Those improvements may include, but are not limited to, extending storm sewers, clearing, dredging, stream bank stabilization, and/or removal of obstructions to open drains or natural water courses, and the removal or replacement of undersized culvert pipes as required by the WPWD.

Regulated Drain Watershed Considerations

If the project site is within a Hamilton County Regulated Drain Watershed, the applicant will also need to abide by the Hamilton County Surveyor's Office applicable detention requirements, whether the site is located in an incorporated area or not.

03302.03
Methodology for
Determination of
Detention Storage
Volume

A. Development Sites Less than or Equal to 5 Acres in Size, With a Contributing Drainage Area Less than or Equal to 50 Acres and No Depressional Storage

The required volume of stormwater storage may be calculated using the Rational Method and based on the runoff from a 100-year return period storm. A computer model, such as TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE), that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies may also be used along with a 24-hour duration NRCS Type 2 storm. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

<p>LID Exception: If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 03700 (Post-Construction Stormwater Quality Management), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 03700 and BMP Fact Sheets may be determined based on pre-development underlying soil layer.</p>

The following 9-step procedure, based on the Rational Method, may be used to determine the required volume of storage

<u>Step</u>	<u>Procedure</u>
-------------	------------------

- | | |
|----|--|
| 1. | Determine total drainage area in acres "A". |
| 2. | Determine the parcel area tributary to each outlet and determine the post-development 100-year release runoff rate (Q_u) based on general release rates provided in Chapter 6 of these Technical Standards document. |
| 3. | Determine composite runoff coefficient " C_d " based on developed conditions and a 100-year return period. |
| 4. | Determine 100-year return rainfall intensity " I_d " for various storm durations " t_d " up through the 24-hour duration using Table 03201-3. |
| 5. | Determine developed inflow rates " Q_d " for various storm durations " t_d ", measured in hours. |

$$Q_d = (C_d)(I_d)(A_d)$$

- | | |
|----|--|
| 6. | Compute a storage rate " $S(t_d)$ " for various storm durations " t_d " up through the 24-hour duration. |
|----|--|

$$S(t_d) = (Q_d) - (Q_u)$$

- | | |
|----|--|
| 7. | Compute required storage volume " S_R " in acre-feet for each storm duration " t_d ". This assumes a triangular hydrograph of duration ($2t_d$) hours with a peak flow of $S(t_d)$ at t_d hours. |
|----|--|

$$S_R = S(t_d) \left(\frac{t_d}{12} \right)$$

- | | |
|----|---|
| 8. | Select largest storage volume computed in Step 7 for any storm duration " t_d " for detention basin design. |
| 9. | Repeat Steps 2-8 of this process for the post-developed 10-year storm. |

B. Development Sites Greater Than 5 Acres in Size or Contributing Drainage Area Greater than 50 Acres or With Significant Depressional Storage

All runoff detention storage calculations for these development sites shall be prepared using a computer model that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas should be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

LID Exception: If Low Impact Development (LID) approach is pursued in satisfying the requirements noted in Chapter 03700 (Post-Construction Stormwater Quality Management), the post-developed CN for the protected undisturbed or restored disturbed areas meeting the requirements described in Chapter 03700 and BMP Fact Sheets may be determined based on pre-development underlying soil layer.

The 24-hour NRCS Type 2 Rainfall Distribution shall be utilized to determine the required storage volume. The allowable release rates shall be determined based on the methodologies provided in Section 03302.02. Examples of computer models that can generate such hydrographs include TR-55 (NRCS), TR-20 (NRCS), HEC-HMS (COE), and HEC-1 (COE). These programs may be downloaded free of charge from the associated agencies' web sites. The computer models ICPR and Pond Pack may also be used. However, the latter computer software are proprietary. If interconnected ponds are utilized, the use of ICPR or Pond Pack may be required to appropriately model the more complex hydrologic and hydraulic relationships associated with such system. Other models may be acceptable and should be accepted by the WPWD prior to their utilization.

03302.04
Management of Off-
Site Runoff

Runoff from all upstream tributary areas (off-site land areas) may be bypassed around the detention/retention facility without attenuation. Such runoff may also be routed through the detention/retention facility, provided that a separate, secondary outlet system is incorporated for the safe passage of such flows, i.e., not through the primary outlet of a detention facility. Unless the pond is being designed as a regional detention facility and therefore all off-site runoff to the pond retained, the primary outlet structure shall be sized and the invert elevation of the secondary outlet for bypassing off-site runoff determined according to the on-site runoff only. To accomplish this, the 100-year on-site runoff must be determined by temporarily ignoring the off-site runoff and routed through the pond and through the primary outlet pipe. The resulting pond elevation would be the invert elevation of the secondary outlet. Once the size and location of the primary outlet structure and the invert elevation of the secondary outlet for off-site runoff are determined by considering on-site runoff only, the size of the secondary outlet and the 100-year pond elevation is determined by routing the entire inflow, on-site and off-site, through the pond. Once the 100-year pond elevation is determined in this manner, the crest elevation of the open emergency weir noted in 03302.10 (below) is set at that elevation. Note that the total peak flow released from the outlet system shall not be larger than the total of the allowable release rate and the off-site flow being bypassed through the pond for the 100-year event.

Note that the efficiency of the detention/retention facility in controlling the on-site runoff may be severely affected if the off-site area is considerably larger than the on-site area. As a general guidance, on-line detention may not be effective in controlling on-site runoff where the ratio of off-site area to on-site area is larger than 5:1. Additional detention (above and beyond that required for on-site area) may be required by the WPWD when the ratio of off-site area to on-site area is larger than 5:1.

03302.05
General Detention
Basin Design
Requirements

1. The detention facility shall be designed in such a manner that a minimum of 90% of the maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of 48 hours from the start of the storm unless additional storms occur within the period. In other words, the design shall ensure that a minimum 90% of the original detention capacity is restored within 48 hours from the start of the design 100-year storm (i.e., within 36 hours after pond reaches its full position).
2. The 100-year elevation of storm water detention facilities shall be separated by not less than 25 feet from any building or structure to be occupied. The Lowest Adjacent Grade (including walkout basement floor elevation) for all residential, commercial, or industrial buildings shall be set a minimum of 2 feet above the 100-year pond elevation or 2 feet above the emergency overflow weir elevation, whichever is higher. In addition to the Lowest Adjacent Grade requirements, any basement floor must be at least a foot above the normal water level of any wet-bottom pond. Special considerations, based on detailed geotechnical analysis,

should be made prior to considering placement of any basement below the 100-year flood elevation of an adjacent flooding source or pond.

3. No detention facility or other water storage area, permanent or temporary, shall be constructed under or within twenty (20) feet of any pole or high voltage electric line. Likewise, poles or high voltage electric lines shall not be placed within twenty (20) feet of any detention facility or other water storage area.
4. All stormwater detention facilities shall be separated from any road right-of-way (using the most restrictive right-of-way possible) by minimum of 50 feet, measured from the top of bank or the 100-year pool if no defined top of bank is present. Use of guard rails, berms, or other structural measures are required and may be considered in lieu of the above-noted setbacks to minimize the chances of vehicles sliding into the pond with approval from the WPWD.
5. Slopes no steeper than 3 horizontal to 1 vertical (3:1) for safety, erosion control, stability, and ease of maintenance shall be permitted.
6. Debris Guard designed in accordance with the WPWD shall be provided for any pipe or opening that receives water.
7. Outlet control structures shall be designed to operate as simply as possible and shall require little or no maintenance and/or attention for proper operation. For maintenance purposes, the outlet shall be a minimum of 0.5 foot above the normal water level of the receiving water body. They shall limit discharges into existing or planned downstream channels or conduits so as not to exceed the predetermined maximum authorized peak flow rate. If an outlet control structure includes an orifice to restrict the flow rate, such orifice shall be no less than 6 inches in diameter, even if the 6 inch diameter orifice results in a discharge that exceeds the predetermined maximum authorized peak flow release rates as determined using methodologies in Section 03302.02. Potential infiltration of accumulated water into the ground shall not be taken into account as part of the calculations for sizing the basin's outlet structure.
8. Grass or other suitable vegetative cover shall be provided along the banks of the detention storage basin. Vegetative cover around detention facilities should be maintained as provided by restrictive covenants, policy or codes.
9. Debris and trash removal and other necessary maintenance shall be performed as provided by restrictive covenants, policy or codes.
10. No residential lots, or any part thereof, shall be used for any part of a detention basin, assumed full to the 100-year water surface elevation or the emergency overflow weir elevation, whichever is higher. Detention basins, assumed full to the 100-year water surface elevation or the emergency overflow weir elevation, whichever is higher, shall be placed within a common area either platted or legally described and recorded as a perpetual stormwater easement. A minimum of fifteen (15) feet horizontally from the top of bank of the facility, or the 100-year pool if no defined top of bank is present, shall be dedicated as permanent stormwater easement if the above-noted boundary of the common area does not extend that far.
11. Detention basins shall be designed with an additional ten (10) percent of available capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings. Basins should be designed to collect sediment and debris in specific locations, such as a forebay, so that removal costs are kept to a minimum. For wet-bottom ponds, the

sediment allowance may be provided below the permanent pool elevation. No construction trash or debris shall be allowed to be placed within the permanent pool. If the pond is used as a sediment control measure during active construction, the performance and maintenance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been reestablished as noted in the accepted plans.

03302.06
Additional
Requirements for
Wet-Bottom Facility
Design

Where part of a detention facility will contain a permanent pool of water, all the items required for detention storage shall apply. Also, a controlled positive outlet will be required to maintain the design water level in the wet bottom facility and provide required detention storage above the design water level. However, the following additional conditions shall apply:

1. Facilities designed with permanent pools or containing permanent lakes shall have a water area of at least one-half (0.5) acre with a minimum depth of eight (8) feet. If fish are to be used to keep the pond clean, a minimum depth of approximately ten (10) feet shall be maintained over at least 25 percent of the pond area. The remaining pond area shall have no extensive shallow areas, except as required to install the safety ramp, safety ledge, and stormwater BMPs as required below. Construction trash or debris shall not be placed within the permanent pool. The pond design shall be according to the City of Westfield Public Works Department Standards and Specifications.
2. A safety ramp exit from the lake may be required in some cases and shall have a minimum width of twenty (20) feet and exit slope of 6 horizontal to 1 vertical (6:1). The safety ramp shall be constructed of suitable material to prevent structural instability due to vehicles or wave action.
3. Periodic maintenance is required in lakes to control weed and larval growth. The facility shall also be designed to provide for the easy removal of sediment that will accumulate during periods of reservoir operation. Maintenance shall be provided by restrictive covenants, policy or codes.
4. Methods to prevent pond stagnation, including but not limited to aeration facilities, should be considered on all wet-bottom ponds. Design calculations to substantiate the effectiveness of proposed aeration facilities, and any impacts on the effectiveness of the pond's use as a stormwater BMP shall be submitted with final engineering plans. Agreements for the perpetual operation and maintenance of aeration facilities shall be included in the restrictive covenants of the development or as provided by policy or codes.

03302.07
Additional
Requirements for
Dry-Bottom Facility
Design

In addition to general design requirements, detention facilities that will not contain a permanent pool of water shall comply with the following requirements:

1. Provisions shall be incorporated into facilities for complete interior drainage of dry bottom facilities, including a minimum 1% bottom slope in all directions if tile underdrains (double wall smooth bore) are provided and a minimum of 2% if no underdrains are provided. A positive/gravity outlet is required for the underdrains in all dry-bottom detention facilities.
2. For residential developments, the maximum planned depth of stormwater stored shall not exceed four (4) feet.
3. In excavated detention facilities, a minimum side slope of 3:1 shall be provided for stability.

03302.08
Parking Lot Storage

Paved parking lots may be designed to provide temporary detention storage of stormwater on all or a portion of their surfaces. Depths of storage shall be limited to a maximum depth of six (6) inches. Ponding should, in general, be confined to those positions of the parking lots farthest from the area served. Before such detention method is allowed, a perpetual maintenance agreement must be executed by the owner or the developer and filed with the WPWD. In addition, the 100-year inundation boundary should be determined and clearly shown on the construction plans.

03302.09
Detention Facilities
in Floodplains

Except for projects exempted under Chapter 03100, Section 03105-01, no detention facilities are allowed to be placed within floodplains of any regulated drain or watercourse that has more than 25 acres of contributing drainage area, whether designated as such on FEMA maps or not.

03302.10
Design of Detention
Facility Emergency
Spillways

Emergency overflow facilities such as a weir or spillway shall be provided for the release of exceptional storm runoff. The overflow facility shall be of such design that its operation is automatic and does not require manual attention.

Emergency overflow facilities shall be designed to convey, without overtopping the detention facility banks, one and one-quarter (1.25) times the peak inflow discharge resulting from the 100-year design storm event runoff from the entire contributing watershed draining to the detention/retention facility, assuming post-development condition on-site and existing condition off-site. The length of the weir is to be determined using the weir equation, with the overflow weir control elevation at the Pond's 100-year elevation (pond is assumed full to the overflow weir control elevation), discharge equal to 1.25 times the peak 100-year inflow, and the maximum head being the difference between the weir control elevation and the top of the bank.

The emergency overflow routing from the emergency overflow facility to an adequate receiving system must be by gravity and the spillway must be set at the highest elevation in the emergency flow routing. The emergency overflow routing and spillway, with a spot elevation labeled, must be shown on the construction plans and on the secondary plat. It must be sized to accommodate the design flow of the pond's emergency overflow weir. Thirty (30) feet along the centerline of this emergency overflow route shall be designated as permanent drainage easement. No fences or landscaping can be constructed within the easement areas. The Lowest Adjacent Grade of all residential, commercial, or industrial buildings along this emergency overflow route shall be set a minimum of 2 feet above the flood elevation along the route, calculated based on the pond's emergency overflow weir design discharge.

03302.11
Acceptable Outlet

Design and construction of the stormwater facility shall provide for the discharge of the stormwater runoff from off-site land areas as well as the stormwater from the area being developed (on-site land areas) to an acceptable outlet(s) (as determined by the WPWD) having capacity to receive upstream (off-site) and on-site drainage.

Outlets into regulated drains or natural watercourses shall provide a positive unobstructed or unrestrictive conveyance into said system. The following provisions shall be followed:

1. All conveyances shall terminate into an approved adequate outlet.
2. All outlets, either open drain or storm sewer, shall extend to the regulated drain or natural watercourse.

3. All storm sewer shall extend to either a receiving storm sewer system or an open regulated drain or natural surface watercourse as approved by the WPWD.
4. Storm sewers shall not outlet into rear yard swales.
5. Outlets shall not directly discharge onto the ground surface as surface flow.
6. Underwater discharges shall not be allowed. All discharges into a watercourse, pond, or lake shall have the invert at or above the normal pool elevation or normal flow elevation for the receiving stream.

The flow path from the development outfall(s) to a regulated drain or natural watercourse (as determined by the WPWD) shall be provided on an exhibit that includes topographic information. Any existing field tile encountered during the construction shall also be incorporated into the proposed stormwater drainage system or tied to an acceptable outlet. In addition, no activities conducted as part of the development shall be allowed to obstruct the free flow of flood waters from an upstream property.

Where the outfall from the stormwater drainage system of any development flows through real estate owned by others prior to reaching a regulated drain or watercourse, no acceptance shall be granted for such drainage system until all owners of real estate and/or tenants crossed by the outfall consent in writing to the use of their real estate through a recorded easement or are notified of such proposal and their rights to appeal any approval of the design. Proof of this notification must be submitted to the jurisdiction entity.

If an adequate outlet is not located on site, then further reduction in allowable release rates or off-site drainage improvements may be required. Those improvements may include, but are not limited to, extending storm sewers, clearing, dredging and/or removal of obstructions to open drains or natural water courses, and the removal or replacement of undersized culvert pipes as required by the WPWD.

Regulated Drain Considerations

If the project site's outlet directly discharges to a Hamilton County Regulated Drain, the applicant will also need to abide by the Hamilton County Surveyor's Office applicable requirements, whether the site is located in an incorporated area or not.

SECTION 03303 OPEN CHANNEL DESIGN

03303.01
Introduction

Open channel flow may be evaluated utilizing Manning's equation, however, restrictions within open channels, such as at open culverts or storm drains, may be required to be evaluated by more sophisticated design methods such as those listed in Section 03303.03.

03303.02
Mannings Equation

The waterway area for channels shall be determined using Manning's Equation, where:

$$A = Q/V$$

A = Waterway area of channel in square feet

Q = Discharge in cubic feet per second (cfs)

V = Steady-State channel velocity, as defined by Manning's Equation (See Section 03305.02)

03303.03
Backwater Method
for Drainage System
Analysis

The determination of 100-year water surface elevation along channels and swales shall be based on accepted methodology and computer programs designed for this purpose. Computer programs HEC-RAS, HEC-2, and ICPR are preferred programs for conducting such backwater analysis. The use of other computer models must be accepted in advance by the WPWD.

03303.04
Appurtenant
Structures

The design of channels will include provisions for operation and maintenance and the proper functioning of all channels, laterals, travelways, and structures associated with the project. Recessed inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the design of channel improvements. The design will also provide for necessary floodgates, water level control devices, and any other appurtenance structure affecting the functioning of the channels and the attainment of the purpose for which they are built.

The effects of channel improvements on existing culverts, bridges, buried cables, pipelines, and inlet structures for surface and subsurface drainage on the channel being improved and laterals thereto shall be evaluated to determine the need for modification or replacement. Culverts and bridges which are modified or added as part of channel improvement projects shall meet reasonable standards for the type of structure, and shall have a minimum capacity equal to the design discharge or governmental agency design requirements, whichever is greater.

03303.05
Grading and Depth
of Open Channels

1. The required channel cross-section and grade are determined by the design capacity, the material in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. The channel grade shall be such that the velocity in the channel is high enough to prevent siltation but low enough to prevent erosion. Velocities less than 2 feet per second are not acceptable, as siltation will take place and ultimately reduce the channel cross-section area. The maximum permissible velocities in vegetated-lined channels are shown in Table 03303.01. In addition to existing runoff, the channel design should incorporate increased runoff due to the proposed development.
2. Where depth of design flow is slightly below critical depth, channels shall have freeboard adequate to cope with the effect of hydraulic jumps.
3. Along the streets and roads, the bottom of the ditch should be low enough to install adequately-sized driveway culverts without creating "speed bumps". The driveway culvert inverts shall be designed to adequately consider upstream and downstream culvert elevations.

4. Flow of a channel into a closed system is prohibited, unless runoff rate and head loss computations demonstrate the closed conduit to be capable of carrying the 100-year channel flow for developed conditions, either entirely or in combination with a defined overflow channel, with no reduction of velocity.
 5. When the design discharge produces a depth greater than three (3) feet in the channel, appropriate safety precautions shall be added to the design criteria based on reasonably anticipated safety needs.
 6. Swale side slopes shall be no steeper than 3 horizontal to 1 vertical (3:1). Flatter slopes may be required to prevent erosion and for ease of maintenance. The swale design shall be according to the City of Westfield Public Works Department Standards and Specifications.
 7. Minimum swale slopes are 1.0%, unless designed to act as a stormwater quality BMP. All flow shall be confined to the specific easements associated with each rear and side lot swale that are part of the minor drainage system. Unless designed to act as a stormwater quality BMP, vegetated swales shall have tile underdrains to dry the swales. Tile lines may be outletted through a drop structure at the ends of the swale or through a standard tile outlet. Further guidance regarding this subject may be found in the latest edition of the Indiana Drainage Handbook.
 8. Residential rear and side lot swales shall not exceed 300 feet in length to any inlet and shall not convey flow from more than 3 lots.
-

03303.06
Channel Stability

Characteristics of a stable channel are:

- a] It neither promotes sedimentation nor degrades the channel bottom and sides.
- b] The channel banks do not erode to the extent that the channel cross-section is changed appreciably.
- c] Excessive sediment bars do not develop.
- d] Excessive erosion does not occur around culverts, bridges, outfalls or elsewhere.
- e] Gullies do not form or enlarge due to the entry of uncontrolled flow to the channel.

Channel stability shall be determined for an aged condition and the velocity shall be based on the design flow or the bankfull flow, whichever is greater, using an "n" value for various channel linings as shown in Table 03303.02. In no case is it necessary to check channel stability for discharges greater than that from a 100-year frequency storm.

Channel stability shall be checked for conditions representing the period immediately after construction. For this stability analysis, the velocity shall be calculated for the expected flow from a 10-year frequency storm on the watershed, or the bankfull flow, whichever is smaller, and the "n" value for the newly constructed channels in fine-grained soils and sands may be determined in accordance with the "National Engineering Handbook 5, Supplement B, Soil Conservation Service" (currently NRCS) and shall not exceed 0.025. This reference may be obtained by contacting the National Technical Information Service in Springfield, Illinois. The allowable velocity in the newly constructed channel may be increased by a maximum of 20 percent to reflect the effects of vegetation to be established under the following conditions:

- a] The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion controlling vegetation.
- b] Species of erosion controlling vegetation adapted to the area, and proven methods of establishment are shown.
- c] The channel design includes detailed plans for establishment of vegetation on the channel side slopes.

Materials acceptable for use as channel lining are:

- 1. Grass (hand sown or hydroseed)
- 2. Revetment Riprap
- 3. Concrete
- 4. Hand Laid Riprap
- 5. Precast Cement Concrete Riprap
- 6. Gabions (or reno mattresses)
- 7. Coconut Matting or erosion control blanket - only until grass is established

Use of bio-engineered (green solution) methods for lining materials is recommended and may be explored, as applicable. Other lining materials must be approved by the WPWD. Materials shall comply with the latest edition of the INDOT Standard Specifications.

03303.07 Drainage System Overflow Design

Ponding and overflow path throughout the development resulting from a 100-year storm event or from a flood route of an internal detention pond or off-site development or watershed, calculated based on all contributing drainage areas, on-site and off-site, in their proposed or reasonably anticipated land use and with the storm pipe system assumed completely plugged, shall be determined, clearly shown as hatched area on the plans, and a minimum width of 30 feet along the centerline of the overflow path contained in permanent drainage easements. A continuous flood route from the sag inlets to the final outfall shall be shown and the minimum 30 feet along the centerline contained within an easement or road right-of-way regardless of the 100-year storm event ponding elevation. A statement shall be added to the secondary plat that would refer the viewer to the construction plans to see the entire extent of overflow path as hatched areas. No fences or landscaping or any other above grade improvements can be constructed within the easement areas that may impede the free flow of stormwater. These areas shall be designated as flood routes and contained in common areas that are to be maintained in accordance with restrictive covenants, codes or policies. The Lowest Adjacent Grade for all residential, commercial, or industrial buildings shall be set a minimum of 1 foot (rather than normal 2 feet, as the storm drains are assumed plugged as an additional safety factor) above the highest noted overflow path/ponding elevation across the property frontage.

All buildings shall have a minimum flood protection grade shown on the secondary plat. Minimum Flood Protection Grade of all structures fronting a pond or open ditch shall be no less than 2 feet (1 foot for the 100-year ponding/overflow paths as the storm drains are assumed plugged as an additional safety factor) above any adjacent 100-year local or regional flood elevations, whichever is greater, for all windows, doors, attached garage entrances, pipe entrances, window wells, and any other structure member where floodwaters can enter a building.

The overflow path/ponding may be modeled as successive series of natural ponds and open channel segments. Consideration shall be given to the highest ground elevations along the overflow path. Ponds should be modeled similar to that discussed for modeling depressional areas in Section 03302.02. Channels should be modeled according to modeling techniques discussed earlier in this Chapter. The calculations for determining

the 100-year overflow path/ponding elevations may be based on hand calculation methods utilizing normal depth calculations and storage routing techniques or performed by computer models. Examples of computer models that either individually or in combination with other models can handle the required computations include TR-20, HEC-HMS, and HEC-1, combined with HEC-RAS. Other models may be acceptable and should be accepted by the WPWD prior to their utilization.

Values in Table 03303.03 may be utilized as an alternative to the above-noted detailed calculations for determining the required LAG or pad elevations of buildings near an overflow path.

If Table 03303.03 is used, WPWD reserves the right to require independent calculations to verify that the proposed building pads/building LAGs provide adequate freeboard above the anticipated overflow path/ponding elevations.

The LAG requirements for buildings adjacent to other flooding sources are discussed in Section 03105.02 of this Manual. In case there are more than one flooding sources applicable to a building site, the highest calculated LAG for the building shall govern the placement of the building on that site

In the case of existing upstream detention, an allowance equivalent to the reduction in flow rate provided may be made for upstream detention only when: (1) such detention and release rate have previously been accepted by the WPWD official charged with the approval authority at the time of the acceptance, and (2) evidence of its construction and maintenance can be shown.

SECTION 03304 CULVERTS/BRIDGES

03304.01 Introduction

The design methods and criteria outlined or referred to within this section shall be used in the design and evaluation of culvert systems within the jurisdiction of this Manual. Computer models such as Federal Highway Administration's HY-8 may be used to perform culvert/bridge design computations.

Culverts/bridges under roadways, involving backwater and/or road overflow during the 100-year design storm, shall be analyzed utilizing the methodologies set forth in Section 03303.03 of this manual for determination of the depth of flow over the culvert/roadway during the peak discharge from the 100-year design storm event, backwater elevations, downstream flow velocities and resulting channel scour impacts.

In addition to satisfying any applicable state agencies' requirements, calculations should be provided showing the impacts of the proposed new or modified culvert/bridge (involving a raise of overflow elevation) for the 2-year through 500-year flood events on upstream elevations and downstream discharges. The design should also ensure that the minimum overflow section elevation (typically located on top of the bridge/culvert or on the approach road to accommodate passage of flood flows larger than the design flood) is not higher than the lowest adjacent grades of buildings located along the stream upstream of the crossing. The requirements of this paragraph also applies to other structures placed within the stream channels, such as fords, low-head dams, weirs, etc.

Additional design requirements for bridges and culverts are contained within Sections 02501 and 03201.03.

SECTION 03305 STORM DRAINS/INLETS

03305.01 Introduction

All storm sewers, whether private or public, and whether constructed on private or public property shall conform to the design standards and other requirements contained herein.

03305.02 Storm Drain Pipe Design

Determination of hydraulic capacity for storm sewers sized by the Rational Method analysis must be done using Manning's Equation where:

$$V = (1.486/n)(R^{2/3})(S^{1/2})$$

Then:

$$Q = (V)(A)$$

where:

Q = capacity in cubic feet per second
V = mean velocity of flow in feet per second
A = cross sectional area in square feet
R = hydraulic radius in feet
S = slope of the energy grade line in feet per foot
n = Manning's "n" or roughness coefficient

The hydraulic radius, R, is defined as the cross sectional area of flow divided by the wetted flow surface or wetted perimeter. Allowable "n" values and maximum permissible velocities for storm sewer materials are listed in Table 03303.02.

03305.03 Backwater Method for Pipe System Analysis

Various computer modeling programs such as HYDRA, ILLUDRAIN, and STORMCAD are available for analysis of storm drains. Computer models to be utilized, other than those listed, must be accepted by the WPWD. The use of submerged storm sewer outfalls is prohibited.

03305.04 Minimum Velocity

Minimum and maximum allowable slopes shall be those capable of producing velocities between 2.5 and 10 feet per second, respectively, when the sewer is flowing full. Maximum permissible velocities for various storm sewer materials are listed in Table 03305.01.

03305.05 Inlet Sizing and Spacing

Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels, or culverts. The inlet grate opening provided shall be adequate to pass the design 10-year flow with 50% of the sag inlet areas clogged. An overload channel from sag inlets to the overflow channel or basin shall be provided at sag inlets. Inlet design and spacing may be done using the hydraulic equations by manufacturers or orifice/weir equations. Use of the U.S. Army Corps of Engineers HEC-12 computer program is also an acceptable method. Gutter spread on continuous grades may be determined using the Manning's equation, or by using Figure 03305.01.

The maximum inlet spacing shall be 400 feet.

Further guidance regarding gutter spread calculation may be found in the latest edition of HERPICC Stormwater Drainage Manual, available from the Local Technical Assistance Program (LTAP). At the time of printing of this document, contact information for LTAP was:

Indiana LTAP
Purdue University
Toll-Free: (800) 428-7369 (Indiana only)
Phone: (765) 494-2164
Fax: (765) 496-1176
Email: inltap@ecn.purdue.edu
Website: www.purdue.edu/INLTAP/

03305.06
Regulated Drain Pipe
Size and Material
Requirements

For storm sewer or subsurface drains that will become regulated drains, the following requirements shall be followed:

1. Storm sewers shall be reinforced concrete pipe with a minimum diameter of 12 inches.
 2. Subsurface drains (SSD) shall be a minimum of 6 inches in depth and shall be double wall, smooth bore perforated plastic pipe.
-

SECTION 306 EASEMENTS

03306.01
Introduction

Guidelines for minimum easement widths are provided below. More stringent requirements for stormwater easement size and additional covenants may be made by the WPWD based upon individual size conditions.

Detention/retention basins shall be constructed within a common area either platted or legally described and recorded as a perpetual stormwater easement. A minimum of fifteen (15) feet horizontally from the top of bank of the facility shall be dedicated as permanent stormwater easement if the boundary of the above-noted common area does not extend that far.

Public street rights-of-ways will not be acceptable areas for construction of detention/retention facilities.

No drainage easement or a combination drainage and utility easement shall be located within a tree preservation easement.

03306.02
Easement
Requirements

There shall be no trees or shrubs planted, nor any structures or fences erected, in any drainage easement, unless otherwise accepted by the WPWD. There shall be no trees within 10' of any storm sewer including SSD.

- A. All new channels, drain tiles equal to or greater than 12 inches in diameter, inlet and outlet structures of detention and retention ponds, and appurtenances thereto as required by this Article, that are installed in subdivisions requiring a stormwater management permit from the WPWD shall be contained within a minimum 20 feet of drainage easement (10 feet from centerline on each side) and shown on the

recorded plat. New drain tiles refer to all sub-surface stormwater piping, tubing, tiles, manholes, inlets, catch basins, risers, etc.

- B. A minimum of 25 feet from top of the bank on each side of a new channel shall be designated on the recorded plat as a Drainage Easement. If the top of bank is not vegetated according the development's landscape plan, a minimum 25 foot width of filter strip shall be installed within the drainage easement.
 - C. Rear-yard swales and emergency overflow paths associated with detention ponds shall be contained within a minimum of 30 feet width (15 feet from centerline on each side) of drainage easement.
 - D. A minimum of 15 feet beyond the actual footprint (top of the bank or the 100-year pond elevation if no top of bank is present) of stormwater detention facilities shall be designated as drainage easement. A minimum 20 foot width easement shall also be required as access easement from a public right-of-way to the facility, unless the pond is immediately next to a public right-of-way.
 - E. The statutory 75-foot (each side) drainage easement for regulated drains already within the Hamilton County system may be reduced if the drain is re-classified by the County Surveyor as an Urban Drain.
 - F. Any outlet to, crossing, and/or encroachment of a Regulated Drainage Easement requires application and acceptance from the Hamilton County Surveyor's Office.
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SECTION 03307 WATERCOURSE IMPROVEMENTS

03307.01 Watercourse Improvement

Whenever a residential subdivision or commercial development constructs improvements upon lands, which is traversed by a watercourse, the landowner/developer shall make improvements to said watercourse at the discretion of the WPWD. These improvements shall consist of the following:

- 1. All debris and obstructions within the channel (bank to bank) shall be removed. This shall include but not be limited to logjams and trash.
 - 2. Clear all trees which are dead and leaning at a 45 degree or greater angle or trees with roots that are exposed in the channel and potentially will fall into the stream. In clearing, the tree shall be cut flush with the ground and treated with an EPA-approved brush killer. For Hamilton County Regulated Drains, refer to the Standard Drawings OD-1, OD-2, or OD-3, as appropriate.
 - 3. All stream bank erosion shall be repaired in an acceptable manner approved by the WPWD.
 - 4. The above required improvements must be reflected on the overall design plans for the development and submitted to the WPWD for prior approval.
-

03307.01 Watercourse Maintenance

Entities owning property through which a watercourse passes, or such an Entity's lessee, shall keep and maintain that part of the watercourse in accordance any applicable City of Westfield ordinances. In addition, the Entity or lessee shall maintain existing privately owned structures within or adjacent to a watercourse, so that such structures will not become a hazard to the use, function, or physical integrity of the watercourse. The Entity or lessee shall not place or construct a privately owned structure(s) or other impairment within or adjacent to the watercourse such that it is an impairment or a detriment or in such a location that is in violation of City of Westfield ordinances.

Regulated Drain Considerations

If the water course is, or directly discharges to, a Hamilton County Regulated Drain, the applicant will also need to abide by the Hamilton County Surveyor's Office applicable requirements, whether the site is located in an incorporated area or not.

TABLE 03303.01

Maximum Permissible Velocities in Vegetal-Lined Channels (1)			
<i>Cover</i>	<i>Channel Slope Range (Percent) (3)</i>	<i>Permissible Velocity (2)</i>	
		<i>Erosion Resistant Soils (ft. per sec.) (4)</i>	<i>Easily Eroded Soils (ft. per sec.) (4)</i>
Bermuda Grass	0-5	8	6
	5-10	7	5
	Over 10	6	4
Bahia Buffalo Grass Kentucky Bluegrass Smooth Brome Blue Grama	0-5	7	5
	5-10	6	4
	Over 10	5	3
Grass Mixture Reed Canary Grass	(3) 0-5	5	4
	5-10	4	3
Lespedeza Sericea Weeping Lovegrass Yellow Bluestem Redtop Alfalfa Red Fescue	(4)		
	0-5	3.4	2.5
	5-10		
Common Lespedeza (5) Sudangrass (5)	(6) 0-5	3.5	2.5

- (1) From Natural resource Conservation Service, SCS-TP-61, "Handbook of Channel Design for Soil and Water Conservation".
- (2) Use velocities exceeding 5 feet per second only where good channel ground covers and proper maintenance can be obtained.
- (3) Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
- (4) Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
- (5) Annuals - use on mild slopes or as temporary protection until permanent covers are established.
- (6) Use on slopes steeper than 5 percent is not recommended.

TABLE 03303.02

Typical Values of Manning's "n"		
<i>Material</i>	<i>Manning's "n"</i>	<i>Maximum Velocities (feet/second)</i>
◆ Closed Conduits		
Concrete	0.013	10
Vitrified Clay	0.013	10
HDPE	0.012	10
PVC	0.011	10
◆ Circular CMP, Annular Corrugations, 2 2/3 x 1/2 inch		
Unpaved	0.024	7
25% Paved	0.021	7
50% Paved	0.018	7
100% Paved	0.013	7
Concrete Culverts	0.013	10
HDPE or PVC	0.012	10
◆ Open Channels		
Concrete, Trowel Finish	0.013	10
Concrete, Broom Finish	0.015	10
Gunitite	0.018	10
Riprap Placed	0.030	10
Riprap Dumped	0.035	10
Gabion	0.028	10
New Earth (1)	0.025	4
Existing Earth (2)	0.030	4
Dense Growth of Weeds	0.040	4
Dense Weeds and Brush	0.040	4
Swale with Grass	0.035	4

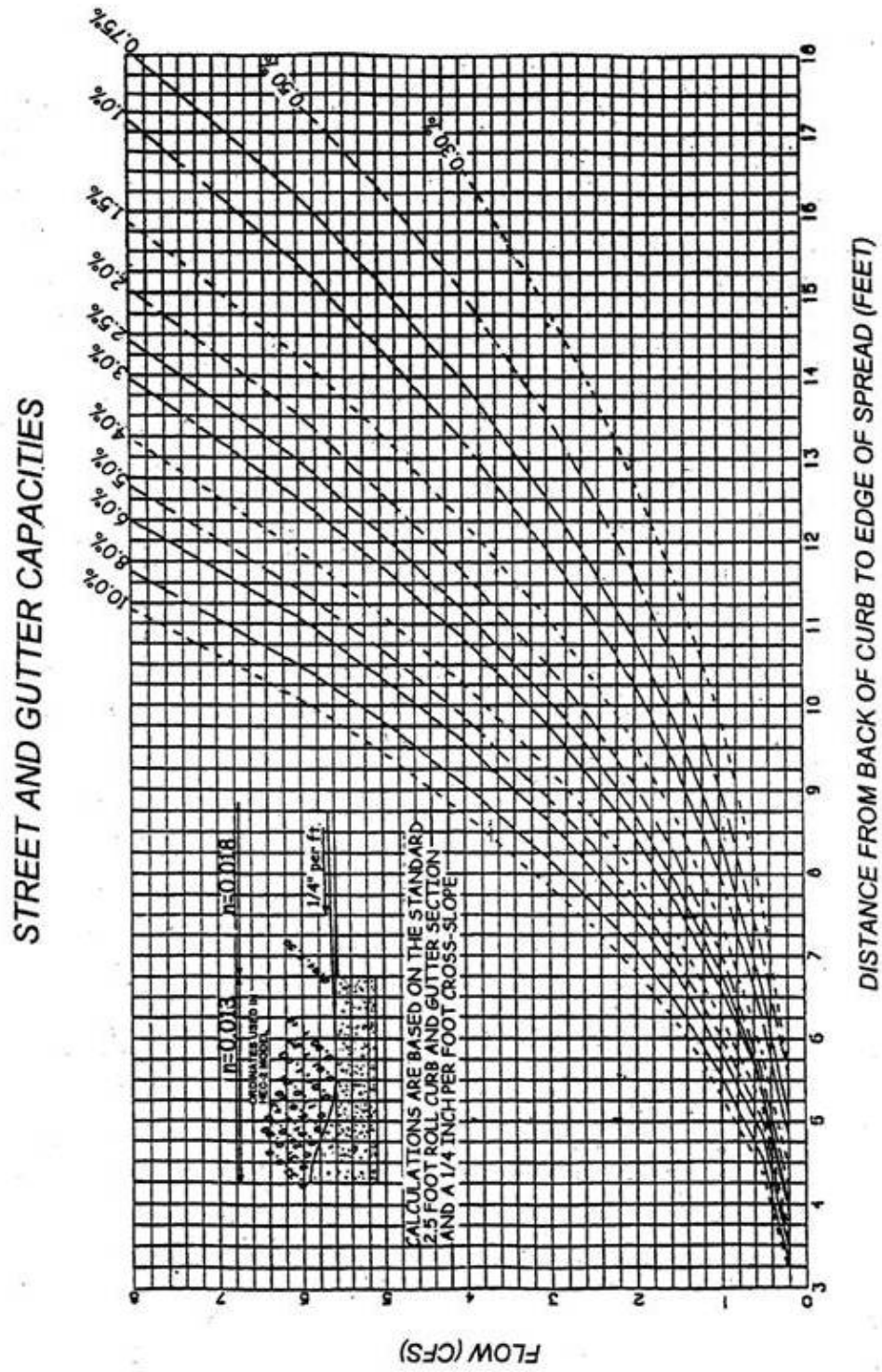
Source of manning "n" values: *HERPACC Stormwater Drainage Manual, July 1995.*

- (1) New earth (uniform, sodded, clay soil)
 (2) Existing earth (fairly uniform, with some weeds).

TABLE 03303.03

Minimum Building LAG Pad Elevations With Respect to Overflow Path Invert Elevations		
Drainage Area (acres)	Minimum Building LAG, Pad, or Flood Protection Grade Above Overflow Path Invert (ft.)	Minimum Building LAG, Pad, or Flood Protection Grade Above Overflow Path Invert, if Overflow Path is in the Street (ft.)
Up to 5	2.5	1.5
6-10	3.0	1.5
11-15	3.25	1.75
16-20	3.5	1.75
21-30	4.0	2.0
30-50	4.25	2.0

FIGURE 03305.01
Street and Gutter Capacities (continuous grade)



CHAPTER 03400 STORM SEWERS AND CULVERTS

SECTION 03401 GENERAL

03401.01 Introduction

This section covers all work necessary for the construction of the storm sewer piping systems and related items complete, including catch basins and inlet drains, manholes, junction chambers, diversion chambers, outfall structures, and miscellaneous structures.

This specification covers the following types of materials for storm sewers, culverts, underdrains, inlet drains, conduits, and miscellaneous applications:

1. Reinforced Concrete Pipe and Fittings
2. Polyvinyl Chloride Pipe (PVC)
3. Corrugated Metal Pipe
4. Structural Plate Arches
5. Aluminum or Aluminized Steel Pipe and Structural Plate
6. Multi-Plate Pipe and Pipe Arches
7. PVC Composite Pipe
8. Corrugated Polyethylene Pipe- SSD (Perforated and Non-Perforated)
9. High-Performance Polypropylene Pipe (HP)

All lots shall have access to a subsurface or storm drain or open ditch.

Storm sewer systems shall have a maximum of four hundred (400) feet between structures.

This specification requires project plans and construction specifications to be submitted to and approved by all appropriate regulatory agencies prior to beginning any work.

Before construction and before fabrication, the Contractor shall submit to the Westfield Public Works Department (WPWD) for approval calculations on the thickness or strength class and drawings showing pipe lengths, joints, and other construction and installation details.

Pipe Marking

Each length of pipe shall bear the name or trademark of the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior or interior of the pipe barrel near the bell or groove end and shall be plainly visible.

03401.02 Minimum Size for Storm Sewers

The minimum diameter of all storm sewers shall be 12 inches. When the minimum 12 inch diameter pipe will not limit the rate of release to the required amount, the rate of release for detention storage shall be controlled by an orifice plate or other device, subject to acceptance of the WPWD.

Manholes, Inlets, and Other Structures

Storm sewer manholes and inlets shall be constructed of precast reinforced concrete. Material and construction shall conform to the latest edition of the Indiana Department of Transportation (INDOT) Standard Specifications, Sections 702 and 720.

Materials for manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall comply with the following:

1. Cement shall be Portland cement and shall meet the requirements of ASTM Specification C150, ACI 301, and ACI 318. Concrete for precast manhole sections shall be 3000 psi concrete. Monolithic manholes shall use 4000 psi concrete. Ready-mix concrete shall conform to ASTM C94, Alternate 2. Maximum size of aggregate shall be 3/4 inch. Slump shall be between 2 and 5 inches.
2. Forms for chamber and structures shall be plywood or other approved material. Steel forms shall be used for the inside face of monolithic concrete manholes. Doghouse structures shall be permitted with approval from the WPWD.
3. Reinforcing steel shall conform to ASTM A615, Grade 60 deformed bars, or ASTM A616 Grade 60 deformed bars.
4. Mortar Materials:
 1. Sand - ASTM Designation C144, passing a No. 8 sieve.
 2. Cement - ASTM Designation C150, Type 1.
 3. Water - shall be potable.

The manufacturer shall provide openings for sewers entering and leaving the manhole. Any additional openings needed to be made in the field shall be made by drilling holes at least 1/2 inch in diameter with a maximum spacing of 3 inches.

Cored or pre-formed holes for pipe installation at manholes shall not occur at barrel section joints. A minimum 3" between edge of hole and joint shall be provided.

Manhole steps shall be made from a steel reinforcing rod encapsulated in a copolymer polypropylene resin. The manhole steps shall equal or exceed OSHA requirements.

Any other special manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall be constructed as detailed on the drawings.

Manhole bases shall be set on a minimum of six (6) inches of # 8 aggregate.

Concrete ends sections shall have a minimum of a twenty-four (24) inch precast toe plate bolted to the end section per Standard Detail (ST-30). Corrugated end sections with toe plates shall require WPWD approval.

Catch Basins

During construction, precautionary measures such as adequate screening of grates shall be maintained to deter earth and other materials from entering the drains.

Catch Basins, for sediment control, locations to be determined by a Professional Engineer, and approved by the WPWD. Catch Basins shall be located within easily accessible dedicated

easements or right of way of sufficient size to facilitate the required maintenance of these structures

Catch basins and curb inlet structures which are two (2) feet by two (2) feet in size shall not have a depth deeper than four (4) feet from the invert of the lowest pipe to the lowest part of the rim elevation of the casting. All beehive castings on a two (2) foot by two (2) foot box shall have a square riser with a round hole. All structures which do not meet these criteria shall be a manhole type, which is forty-eight (48) inches in diameter.

Castings

Cast iron or ductile iron frames and gratings for catch basins and drain inlets shall be as shown on the drawings. Bearing surfaces shall be clean and shall provide uniform contact. Castings shall be tough, close-grained gray iron, sound, smooth, clean, free from blisters, blow holes, shrinkage, cold shuts, and all defects and shall conform to ASTM A48 Class No. 30-B.

During construction, precautionary measures such as adequate screening of grates shall be maintained to deter earth and other materials from entering the drains.

The following castings types are required:

1. Manholes – Neenah R 1772 A or equivalent
2. Beehive Inlets – Neenah R 4342 or equivalent
3. “Roll Curb” Inlets – Neenah 3501 – TR or TL or equivalent
4. “Chair Back” Curb Inlet – Neenah 3287 – 10V or equivalent
5. Other types shall require approval of the WPWD.

1. All equivalents shall be approved by WPWD

Curb inlet castings which possess open backs or have grate bars parallel to traffic flow (are not “bicycle” safe) will not be accepted by the WPWD.

Storm sewer casting manhole covers, beehive inlets, curb inlets or other approved casting shall have the following phrases cast in recessed letters two (2) inches in height:

1. “City of Westfield Storm”

2. “Drains to River” or “Drains To Waterway”
3. “Dump No Waste”
4. Other phrases shall require approval of the WPWD.

All casting frames shall have a horizontal bearing surface around the entire perimeter of the frame in order to support the cover or grate.

Bench Walls

Bench walls shall be shaped and formed for a clean transition with proper hydraulics to allow the smooth conveyance of flows through the structure. The bench wall shall form a defined channel, to a minimum height of the spring line of the pipe.

Bench walls shall be formed using full depth Class "A" concrete. Solid concrete block, stone or sand shall not be permitted as a base or filler for the construction of the bench wall.

Reinforced Concrete Pipe and Fittings

Reinforced concrete pipe and fittings shall conform to ASTM C76, latest revision, for circular pipe and ASTM C507 for elliptical pipe.

Reinforced concrete pipe and fittings for normal conditions shall be reinforced in accordance with ASTM C76, Class III, IV or V, Wall B (minimum). Acceptance shall be on the basis of Subsection 4.1.1 of ASTM C76.

Circumferential reinforcing in circular pipe shall be required. Only with approval from the WPWD will elliptical reinforcing or combination of elliptical and circumferential reinforcing or part circular reinforcing shall be permitted, in circular pipe.

Concrete pipe shall be steam cured and shall not be shipped from point of manufacture for at least five days after having been cast.

Joints shall conform to the requirements of ASTM C443. Gaskets shall be of an oil resistant type having a maximum swell of 90% when tested in accordance with ASTM D471. Lubricant for jointing shall be approved by gasket manufacturer.

All rubber gaskets shall be similar to and equal to "Press-Seal" or "Tylox" conforming to ASTM Designation C443, latest revision. The gasket shall be attached to the spigot of the pipe and shall be the sole element depended upon to make the joint flexible and practically watertight.

Butyl mastic joint sealant in rope or trowel applied form specifically made for permanently sealing joints in tongue and groove concrete sewer pipe. The material shall adhere tightly to the pipe surface and form a tight, flexible joint. The material shall have been in use for at least five years. Test results and material specifications shall be submitted to the WPWD and shall be approved prior to use on the project.

Polyvinyl Chloride Pipe and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall comply with ASTM D3034.

Corrugated Metal Pipe and Pipe Arches

The following specifications shall govern the manufacture of the corrugated steel pipe and pipe arches.

1. Specifications for Zinc Coated (galvanized) Steel Sheets (ASTM A444).
2. Manufacture of Corrugated Steel Culverts and Underdrains (AASHTO M-36).
3. Structural Plate for Pipe, Pipe Arches, and Arches (AASHTO M-167).
4. Bituminous Coated Corrugated Steel Pipe and Arches (AASHTO M-190).
5. Sheet Material (ASTM A525).

Bituminous Coated Welded Seam Helically Corrugated Steel Pipe

The pipe shall be fabricated from flat coils. The base metal, spelter coating, and fabrication shall meet the applicable requirements of AASHTO M-36. Corrugations shall be 2-2/3 inch pitch by 1/2 inch depth. Each pipe shall have two annular corrugations rolled in each end. After the ends

are rolled, the pipe shall be coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch as required by AASHTO M-190 for Type A coating.

Bituminous Coated and Paved Invert Welded Seam Helically Corrugated Steel Pipe

The pipe shall be fabricated from flat coils. The base metal, spelter coating, and fabrication shall meet the applicable requirements of AASHTO M-36. Corrugations shall be 2-2/3 inch pitch by 1/2 inch depth. Each pipe shall have two annular corrugations rolled in each end.

After the ends are rolled, the pipe shall be coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch. In addition, bituminous material shall be applied to form a smooth pavement in the bottom 25% of pipe and in the bottom 40% of pipe arch as required by AASHTO M-190 for Type C coating.

Smooth Lined Welded Seam Helically Corrugated Steel Pipe

The pipe shall be fabricated from flat coils. The base metal, spelter coating, and fabrication shall meet the applicable requirements of AASHTO M-36. Corrugations shall be 2-2/3 inch pitch by 1/2 inch depth. Each pipe shall have two annular corrugations rolled in each end. Each pipe shall have two lifting lugs welded to the outside of the pipe.

After the ends have been rolled, the pipe shall be coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch as required by AASHTO M-190 for Type A coating. The pipe shall be centrifugally lined on the inside with bituminous material to form a smooth surface which fills the corrugations to a minimum thickness of 1/8 inch above the crests of the corrugations. The bituminous lining material shall meet the requirements of AASHTO M-190.

Bituminous Coated Pipe Couplings

Coupling bands shall be the same base metal and spelter coating as the pipe. Bands shall be 0.064 inch thick and 10-1/2 inches wide. Bands shall be bituminous coated and shall have two corrugations 7-5/8 inches center to center. Bands 12 inch diameter through 30 inch diameter shall be one-piece and 36 inch diameter through 96 inch diameter shall be two-piece. Band laps 12 inch diameter through 48 inch diameter shall be joined by one galvanized bar, bolt, and strap connector. Band laps 54 inch diameter through 96 inch diameter shall be joined by two galvanized bar, bolt, and strap connectors.

Aluminum Alloy Structural Plate

Aluminum alloy plates and fasteners intended for use in the construction of structural plate pipe and pipe arch for storm sewers shall meet the applicable requirements of AASHTO M-219. The plate shall be fabricated from aluminum alloy 5052 H141. The chemical composition of the plates shall conform to ASTM B209 alloy 5052.

The corrugations shall have a pitch of 9 inches plus or minus 3/8 inch and depth of 2-1/2 inches plus or minus 1/8 inch. The inside crown radius of the corrugations shall be not less than 2 inches.

The structural plate pipe or arches shall be assembled in accordance with the manufacturer's erection instructions and in accordance with the drawings.

Aluminized Steel Pipe and Arches

Aluminized coated corrugated steel pipe and pipe arch intended for use in the construction of storm sewers shall meet the applicable requirements of AASHTO M-36. Sheet material shall meet the latest revision of ASTM A525 and AASHTO M-274. The coils from which the pipe is produced shall be coated with 1.0 ounce per square foot of commercially pure aluminum.

Pipe shall be furnished circular or as a pipe-arch shape as required and shall be fabricated with helical corrugations and a continuous welded seam extending from end to end of each length of pipe.

Each end of each pipe with the welded seam shall have two annular corrugations reformed to permit joining with hugger bands.

Coupling bands shall be hugger bands.

Multi-plate Pipe and Pipe Arches

Multi-plate pipe and pipe arch structures shall be in accordance with AASHTO M-167. They shall be made with steel sections with corrugations 6 inches wide by 2 inches deep running at right angles to the section.

Bolts and nuts shall be special heat-treated galvanized 3/4 inch diameter bolts in accordance with ASTM specifications.

Multi-plate pipes and pipe arches shall be designed in accordance with the manufacturer's design criteria and in accordance with the drawings.

Detailed instructions regarding erection shall be furnished by the manufacturer.

PVC Composite Pipe and Fittings

ABS or PVC composite pipe and fittings shall conform to ASTM D2680, Latest Revision.

Corrugated Polyethylene Pipe and Fittings

Corrugated polyethylene pipe shall comply with the requirements for materials, test methods, dimensions, and marking in accordance with AASHTO M-252 for pipe diameters 6" - 10".

The resin material shall meet ASTM D3350 cell classification 335400C.

The pipe lengths shall be connected using a gasketed, bell and spigot joint. This joint shall consist of a factory installed, gasketed double bell polyethylene coupling, a factory welded bell or integral bell. The spigot end of the pipe shall be furnished with a factory installed elastomeric profile "O-ring" rubber gasket that meets ASTM F477.

The pipe shall be shipped with a removable wrap to protect the gasket. Provide lubrication to the joint prior to pushing together. At least two (2) corrugations of the spigot end must insert into the bell end.

All HDPE pipe shall be certified through the Plastic Pipe Institute (PPI) Third Party Certification Program. All HDPE pipe delivered and installed shall bear the Third Party Administered PPI Seal.

High-Performance Polypropylene Pipe (HP)

This specification describes 12- through 60-inch (300 to 1500 mm) ADS HP Storm pipe for use in gravity-flow storm drainage applications.

12- through 60-inch (300 to 1500 mm) pipe shall have a smooth interior and annular exterior corrugations and meet or exceed ASTM F2881 and AASHTO M330. Manning's "n" value for use in design shall be 0.012. Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of F2881. 12- through 60-inch (300 to 1500 mm) shall be watertight according to the requirements of ASTM D3212. Spigots shall have gaskets meeting the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

Fittings shall conform to ASTM F2881 and AASHTO M330. Bell & spigot connections shall utilize a spun-on, welded or integral bell and spigots with gaskets meeting ASTM F477. Bell & spigot fittings joint shall meet the watertight joint performance requirements of ASTM D3212. Corrugated couplings shall be split collar, engaging at least 2 full corrugations.

To assure water-tightness, field performance verification may be accomplished by testing in accordance with ASTM F1417 or ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F2881, Section 5 and AASHTO M330, Section 6.1.

Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in traffic areas for 12- through 48-inch (300 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameters, the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1, Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.04 at http://www.ads-pipe.com/pdf/en/2.04_Min_Max_Cover_Heights_for_HP_Storm_December_2016.pdf.

For additional backfill details, refer to WSD 2222-001 through 004.

Mandrel testing for 100% of the installed pipe will be required unless otherwise approved by WPWD Inspector.

Subsurface Drain Tiles

Double wall, smooth bore perforated, corrugated polyethylene tile, manufactured under specification ASTM F667, shall be required for all subsurface drain tile installed in swales. Double wall, smooth bore perforated, corrugated polyethylene drain tile shall be required for curb sub-grade drainage. All ends shall be capped with HDPE fitting. No duct tape shall be permitted.

Polyethylene tile shall possess male and female pipe ends, which allow the construction of overlapping, gasket pipe joints, in conformance with the requirements of ASTM D3212. The gasket material shall conform to all requirements of ASTM F477. As an alternative, pipe joints utilizing external couplings bands will be accepted provided the minimum AASHTO requirements for satisfying soil tightness are also achieved.

Storm sewer pipe shall be of the size shown on the drawings and shall meet all requirements of these specifications. Subsurface drains in swales shall have clean-outs installed every 300 feet, changes in direction, high points, and dead ends.

CHAPTER 03500 INSTALLATION OF STORMWATER FACILITIES

SECTION 03501 GENERAL

03501.01
Pipe Cover,
Grade, and
Separation from
Sanitary Sewers

Pipe

Pipe grade shall be such that, in general, a minimum of 2.0 feet of cover is maintained over the top of the pipe. If the pipe is to be placed under pavement, then the minimum pipe cover shall be 2.5 feet from top of pavement to top of pipe. Uniform slopes shall be maintained between inlets, manholes and inlets to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems, and other design parameters. Minimum and maximum allowable slopes shall be those capable of producing velocities of between 2.5 and 10 feet per second, respectively, when the sewer is flowing full. Maximum permissible velocities for various storm sewer materials are listed in Table 03501-1. A minimum of 18 inches of vertical separation between storm sewers, water and sanitary sewers shall be required. When this is not possible, the sanitary sewer must be encased in concrete or ductile iron within 5 feet, each side, of the crossing centerline and in relation to the waterline, water class pipe must be used for the storm and sanitary sewers. Minimum horizontal separation between storm sewers, water and sanitary sewers shall be 10.0 feet and 8.0 feet to the structures. All other utilities shall maintain a minimum separation of 3.0 feet from storm structures.

Rear Yard Swale

Rear yard swales shall have a minimum slope of 2% gradient. Swales less than a 2% gradient are required to have double wall, smooth bore perforated drain tile installed two (2) feet below the invert of the swale. Minimum swale slope shall be greater than 1% gradient. Subsurface drains shall have a minimum slope of 0.5% gradient.

Proposed road grades will be required to be graded within two (2) inches of the proposed sub-grade prior to installation of SSD. Trench width for SSD shall be a minimum of three (3) inches on both sides of the SSD, with a minimum trench width of twelve (12) inches.

03501.02
Alignment

Storm sewers shall be straight between manholes and/or inlets.

03501.03
Manholes/Inlets

All manholes and inlets must be pre-stamped with an appropriate message per the City of Westfield Public Works Department Standards and Specifications. Manholes and/or inlets shall be installed to provide human access to continuous underground storm sewers for the purpose of inspection and maintenance. The casting access minimum inside diameter shall be no less than 22 inches or a rectangular opening of no less than 22 inches by 22 inches. Manholes shall be provided at the following locations:

1. Where two or more storm sewers converge.
2. Where pipe size or the pipe material changes.
3. Where a change in horizontal alignment occurs.
4. Where a change in pipe slope occurs.

5. At intervals in straight sections of sewer, not to exceed the maximum allowed. The maximum distance between storm sewer manholes shall be as shown in Table 03501-2.

In addition to the above requirements, a minimum drop of 0.1 foot through manholes and inlet structures should be provided. Pipe slope should not be so steep that inlets surcharge (i.e. hydraulic grade line should remain below rim elevation).

Manhole/inlet inside sizing shall be according to the City of Westfield Public Works Department Standards and Specifications. Note that the WPWD may require the applicant to provide pre-treatment BMPs prior to discharge of the storm sewer line into a pond.

03501.04
Installation and
Workmanship

Bedding and backfill materials around storm sewer pipes, subsurface drains, and the associated structures shall be according to the City of Westfield Public Works Department Standards and Specifications. The specifications for the construction of storm sewers and subsurface drains, including backfill requirements, shall not be less stringent than those set forth in the latest edition of the INDOT Standard Specifications. Additionally, ductile iron pipe shall be laid in accordance with American Water Works Association (AWWA) C-600 and clay pipe shall be laid in accordance with either American Society of Testing Materials (ASTM) C-12 or the appropriate American Association of State Highway and Transportation Officials (AASHTO) specifications. Dips/sags on newly installed storm systems will not be allowed. Also, infiltration from cracks, missing pieces, and joints shall not be allowed. Variations from these standards must be justified and receive approval from the WPWD. Notification must be made to WPWD inspectors at least 48 hours prior to installation. All structures shall require inspection prior to backfill.

03501.05
Special Hydraulic
Structures

Special hydraulic structures required to control the flow of water in storm runoff drainage systems include junction chambers, drop manholes, stilling basins, and other special structures. The use of these structures shall be limited to those locations justified by prudent planning and by careful and thorough hydraulic engineering analysis. Certification of special structures by a certified Structural Engineer may also be required.

The use of stormwater lift stations will not be permitted under any circumstances.

03501.06
Connections to
Storm Sewer
System

Unless otherwise approved, perforated subsurface drain tiles, footer drains, or sump pumps lines shall connect to a storm structure. Storm sewer connections shall be provided by either precast or core drilled holes, which are to be a minimum of two (2) inches larger than the O.D. of the connecting tile. Drain tile connections shall be made with either "Tee" or "Wye" method. If no storm infrastructure is available, these lines discharge lines shall be appropriately daylighted.

Blind connections to storm sewer pipes shall not be allowed.

Subsurface drain tile as specified herein may be used to convey water collected in sump pits and footer drains to an acceptable storm sewer outlet, provided these drain tiles are properly sized to accept these flows.

Gutter or building drains shall not be allowed to outlet directly into storm sewer systems.

To allow any connections to the storm sewer system, provisions for the connections shall be shown in the drainage calculations for the system. Specific language shall be provided in the protective covenants, on the record plat, or with the parcel deed of record, noting the ability or inability of the system to accommodate any permitted connections, for example, sump pumps and footing drains.

1. **Sump pumps** installed to receive and discharge groundwater or other stormwater shall be connected only into "D" subsurface drain (SSD) lateral connection. Sump pumps installed to receive and discharge floor drain flow or other sanitary sewage shall be connected to the sanitary sewers. A sump pump shall be used for one function only, either the discharge of stormwater or the discharge of sanitary sewage, each being connected to the respective receiving system only.
2. **Footing drains and perimeter drains** shall be connected only into "D" subsurface drain (SSD) lateral connection.
3. All **roof downspouts**, roof drains, or roof drainage piping shall discharge onto the ground and shall not be directly connected to the storm drainage system. Variation from this requirement may be requested and granted by the WPWD in special circumstances. No downspouts or roof drains shall be connected to the sanitary sewers.
4. **Garage and Basement floor drains and water softener discharge** shall not be connected to the storm sewers.
5. **Swimming Pool drains** shall not be connected to the storm sewers unless the water is dechlorinated prior to being connected to the storm sewer.

03501.07
Inspection and
Rejection of Pipe

The quality of all materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the WPWD. Such inspection may be made at the place of manufacture or on the construction site after delivery, or at both places; and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications' requirements even though sample pipes may have been accepted as satisfactory at the place of manufacture.

Prior to being lowered into the trench, each pipe shall be carefully inspected and those not meeting the specifications shall be rejected and at once removed from the work.

The WPWD shall have the right to cut cores from such pieces of the concrete pipe as the inspector desires for such inspection and tests as the inspector may wish to apply. The Developer/Contractor shall pay for the samples of an Independent Laboratory Testing.

Holes left by the removal of cores shall be filled in an approved manner by and at the expense of the manufacturer of the pipe.

The WPWD shall also have the right to take samples of concrete after it has been mixed, or as it is being placed in the forms or molds, and to make such inspection and tests thereof as the inspector may wish.

Any pipe which has been damaged after delivery will be rejected and replaced solely at the Contractor's expense.

After installation, any deficiencies in the pipe revealed during the televising review shall be repaired by the Contractor, as noted below:

1. RCP
 - a. Remove damaged pipe section and continue removal of pipe sections to the nearest structure, or
 - b. An interior pipe lining or patching method, as approved by WPWD.
2. SSD
 - a. An approved flexible coupling with stainless steel clamps, or

- b. An external snap coupling.
 - c. Split couplers or internal couplers shall not be permitted.
3. If a different pipe material is used, consult with WPWD for an approved method of repair.

03501.08
Handling Pipe

Each pipe section shall be handled into its position in the trench only in such manner and by such means as the WPWD approves as satisfactory. The Contractor will be required to furnish slings, straps, and other approved devices to permit satisfactory support of all parts of the pipe when it is lifted.

03501.09
Notice to
WPWD

The WPWD shall be notified at least 48 hours prior to when the pipes are to be laid in the trench. At least 15 feet of the pipe shall, under ordinary circumstances, be laid before covering begins.

03501.10
Laying Pipe

All pipes shall be re-inspected for soundness and damage due to handling immediately before being lowered into the trench. Any pipe found to be unsound or damaged will be rejected and shall be removed immediately from the site of the work.

Except by permission of the WPWD not more than 100 feet of trench shall be opened at any one time. Not more than 30 feet of trench may be opened in advance of the completed pipe laying operation, and not more than one street crossing may be obstructed by the same trench at any one time.

No portion of a storm sewer pipe, open culvert, manhole, inlet, or subsurface drain tile system shall be installed directly or indirectly onto frozen ground or with frozen backfill materials.

Where ground water is encountered, the contractor shall make every effort necessary to secure a dry trench bottom prior to installation of the storm water system. The contractor shall be required to maintain the groundwater level below the base of the excavation. The City nor the Westfield Public Works Department, will not assume any liability for the actions of the Developer or Contractor in the performance of the required dewatering operation. If trench conditions outlined in this section cannot be achieved, the WPWD may terminate installation until such efforts can be achieved.

All pipes shall be laid accurately to the required line and grade as shown on the drawings, and in the manner prescribed by the pipe manufacturer and appropriate ASTM Specifications, to form a close, concentric joint with the adjoining pipe and to bring the invert of each section to the required grade. The supporting of pipe on block will not be permitted.

Pipe laying shall precede upgrade, beginning at the lower end of the sewer.

Practically, watertight work is required, and the Contractor shall construct the sewers with the type of joint specified.

Joints between precast structures shall be sealed with (1) An approved rubber gasket manufactured and installed in accordance with ASTM C 443, latest version, (2) A 1/2 inch diameter non-asphaltic mastic (Kent Seal or approved equal) conforming to AADHTO M-198 and Federal Specifications SS 521-A, or (3) mortar or butyl rubber sealed on the outside

Regardless of the method chosen above, mortar sealed on the inside and brushed smooth is required.

The annular space between the pipe and precast structure walls shall be filled inside and outside with Class "A" Concrete. No grout mixtures will be permitted. Collars shall be formed around the annular space between the pipe and precast structure and trowel and broom finished.

All pipes shall be laid to the line and grade as shown on the drawings. Variations from a uniform line and grade as shown on the drawings shall be cause for the line to be rejected.

The ends of the pipe shall be satisfactorily cleaned just before laying, and the joint shall be made in a satisfactory manner in accordance with the recommendations of the manufacturer on the particular type of joint. All joint work shall be done by experienced workmen.

All pipes shall be bedded as described in this specification under Pipe Bedding. Bell holes shall be excavated in advance of pipe laying so the entire pipe barrel will bear uniformly on the prepared subgrade.

Each length of pipe shall be mechanically pulled "home" with a winch or come-along against the section previously laid and held in place until the trench and bedding are prepared for the next pipe section. Care shall be taken in laying the pipe so not to damage the bell or the spigot end of the pipe. Mechanical means consisting of a cable placed inside the pipe with a winch, jack, or come-along shall be considered to pull the pipe home where pushing the pipe will not result in a joint going completely home and staying in place.

The Contractor shall use laser beam equipment, surveying instruments, or other proven techniques to maintain accurate alignment and grade.

Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipe line to prevent flotation of the pipe line. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any such open end of unplugged branch must be removed at the Contractor's expense. The cost of all such plugs, and the labor connected therewith, must be included in the regular bid for the sewers.

Storm sewer which outlets into a Hamilton County Regulated Drain shall be approved, inspected, and constructed per the latest standards of the Hamilton County Surveyor's Office.

03501.11
Pipe Bedding
and Haunching

Each pipe section shall be laid in a firm foundation of bedding material and haunched and backfilled with care.

Prior to pipe installation, carefully bring bedding material to grade along the entire length of pipe to be installed. To provide adequate support for the pipe, the following bedding procedures shall be followed.

When angular 1/4 to 1/2 inch (6 to 12 mm) clean graded stone, slag, or crushed stone material is used for bedding, little or no compaction is necessary due to the nature of the angular particles. A depth of 4 to 6 inches is generally sufficient to provide uniform bedding. If Class I material is used for bedding, it must also be utilized for haunching up to or higher than the spring line of the pipe to avoid loss of side support through migration of Class II haunching material into the bedding.

1. Take care with coarse sands and gravels and maximum size 20 mm (3/4 inch) materials, to provide uniformly compacted bedding. Excavate the bedding material or place it to a point above the pipe bottom, determining such point by the depth of loose material resulting in the preparation of the bedding and the amount of compaction that will be

required to bring the material to grade. Use hand or mechanical tamping to compact the bedding material to a minimum 85% Standard Proctor Density.

2. Slightly damp material will generally result in maximum compaction with a minimum of effort. If water is added to improve compaction or if water exists in the trench, take care to avoid saturation of Class II material, which could result in additional stability problems. Check grade of bedding after compaction.

Bedding material shall have a minimum thickness beneath the pipe of 4 inches (100 mm) or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth of the outside diameter of the pipe.

The rigid pipe, such as concrete or ductile iron, backfill between the bedding material and a plane 12 inches (300 mm) over the top of the pipe shall be hand-placed finely divided earth, free from debris and stones, or granular backfill if required.

For flexible pipe, corrugated metal pipe, the placement of embedment material or haunching around the pipe must be done with care. The ability of the pipe to withstand loading in a trench depends a large part on the method employed in its installation. If crushed stone, pea gravel, or graded gravel or sand is used to backfill between the bedding material and a plane 12 inches (300 mm) over the top of the pipe, it shall be hand placed. If fine sand, silt, or clayey gravels are used for initial backfilling over the pipe, the material shall be hand placed in 6 to 8 inch layers and hand compacted on both sides of the pipe to an elevation 12 inches (300 mm) over the top of the pipe. Care should be taken so not to compact directly over the pipe.

In yielding subsoils, the trench bottom shall be undercut to the depth necessary and backfilled with graded, crushed stone to form a firm foundation.

Where excavation occurs in rock or hard shale, the trench bottom shall be undercut and a minimum of 6 inches (150 mm) crushed stone bedding placed prior to pipe installation.

03501.12
Concrete Cradle
(Class "A"
Bedding)

Concrete cradles shall be constructed of Class "A" concrete and of the design shown on the detailed drawings.

03501.13
Manholes and
Other
Structures

Manholes and other structures are to be constructed at locations shown on the drawings and in accordance with the following specifications:

Precast concrete manhole sections shall conform to ASTM Designation C478, except as modified herein:

1. The joint design of the precast sections shall consist of a bell or groove on one end of the unit of pipe and a spigot or tongue on the adjacent end of the joining section.
2. The joint shall consist of a flat rubber gasket attached to the spigot end of the precast manhole section and shall conform to Sections 6.1.6, 6.1.7 and 9 of ASTM Designation 443, latest revision.

Openings in manhole sections for sewer connections shall be cut at the point of manufacture and shall be circular or horseshoe shaped with grooved or roughened surfaces to improve mortar bond. Doghouse structures shall be permitted with approval from the WPWD.

Manhole bases shall be cast-in-place concrete, reinforced as shown on the Standard Detail Sheet. Manhole bases shall be cast on a minimum of 6 inches of compacted crushed stone.

Manhole channels or inverts (flow lines) shall be preformed and poured with Class "A" concrete to the spring line of the connecting pipe. The finished invert shall be a semi-circular shaped, trowel and broom finished, smooth channel directing the flow to the downstream sewer.

Manhole frames and lids shall be of good quality cast iron, conforming to ASTM Designation A48 and as shown on Westfield Standard Drawing 03800-007. Unless specifically designated otherwise, manhole castings shall be the non-locking type. The joint between the casting frame and cone section shall be fully mortared or gasketed and coated with butyl rubber or a coal tar epoxy coating upon reaching its final set to become a watertight joint. The casting frame shall be bolted through all risers and into the cone section.

Manhole steps shall be made from a steel reinforcing rod encapsulated in a copolymer polypropylene resin. Steps shall be placed as shown on the drawings.

TABLE 03501-1

Typical Values of Manning's "n"		
<i>Material</i>	<i>Manning's "n"</i>	<i>Maximum Velocities (feet/second)</i>
<input type="checkbox"/> Closed Conduits		
Concrete	0.013	10
Vitrified Clay	0.013	10
HDPE	0.012	10
PVC	0.011	10
<input type="checkbox"/> Circular CMP, Annular Corrugations, 2 2/3 x 1/2 inch		
Unpaved	0.024	7
25% Paved	0.021	7
50% Paved	0.018	7
100% Paved	0.013	7
Concrete Culverts	0.013	10
HDPE or PVC	0.012	10
<input type="checkbox"/> Open Channels		
Concrete, Trowel Finish	0.013	10
Concrete, Broom Finish	0.015	10
Gunitite	0.018	10
Riprap Placed	0.030	10
Riprap Dumped	0.035	10
Gabion	0.028	10
New Earth (1)	0.025	4
Existing Earth (2)	0.030	4
Dense Growth of Weeds	0.040	4
Dense Weeds and Brush	0.040	4
Swale with Grass	0.035	4

Source of manning "n" values: HERPICC Stormwater Drainage Manual, July 1995.

- (1) New earth (uniform, sodded, clay soil)
- (2) Existing earth (fairly uniform, with some weeds).

TABLE 03501-2

Maximum Distance Between Manholes	
Size of Pipe (Inches)	Maximum Distance (Feet)
All sizes	400

CHAPTER 03600 EROSION AND SEDIMENT CONTROL FOR CONSTRUCTION SITES

SECTION 03601 GENERAL

03601.01 Purpose and Background

The requirements contained in this Chapter are intended to prevent stormwater pollution resulting from soil erosion and sedimentation or from mishandling of solid and hazardous waste. Practices and measures included herein should assure that no foreign substance, (e.g. sediment, construction debris, chemicals) be transported from a site and allowed to enter any drainageway, whether intentionally or accidentally, by machinery, wind, rain, runoff, or other means.

The major pollutant of concern during construction is sediment. Natural erosion processes are accelerated at a project site by the construction process for a number of reasons; including the loss of surface vegetation and compaction damage to the soil structure itself, resulting in reduced infiltration and increased surface runoff. Clearing and grading operations also expose subsoils which are often poorly suited to re-establish vegetation, leading to longer term erosion problems.

Problems associated with construction site erosion include: transport of pollutants attached to displaced sediment; increased turbidity (reduced light) in receiving waters; and recreational use impairment. The deposited sediment may pose direct toxicity to wildlife, or smother existing spawning areas and habitat. This siltation also reduces the flow capacity of waterways, resulting in increased flood hazards to the public.

Other pollutants of concern during the construction process are hazardous wastes or hydrocarbons associated with the construction equipment or processes. Examples include concrete washouts, paints, solvents, and hydrocarbons from refueling operations. Poor control and handling of toxic construction materials pose an acute (short-term) and/or chronic (long-term) risk of death to aquatic life, wildlife, and the general public.

03601.02 Abbreviations and Definitions

The following abbreviations and definitions apply throughout this chapter:

Abbreviations

COE:	United States Army Corps of Engineers
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IDEM:	Indiana Department of Environmental Management
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IDNR:	Indiana Department of Natural Resources
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INDOT:	Indiana Department of Transportation
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MS4:	Municipal separate storm sewer system
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NRCS: USDA-Natural Resources Conservation Service

SWCD: Soil and Water Conservation District

USDA: United States Department of Agriculture

Definitions

Construction Activity: Land-disturbing activities associated with the construction of infrastructure and structures. This term does not include routine ditch maintenance or minor landscaping projects.

Construction Plan: A representation of a project site and all activities associated with the project. The plan includes the location of the project site, buildings and other infrastructure, grading activities, schedules for implementation and other pertinent information related to the project site. A stormwater pollution prevention plan is a part of the construction plan.

Construction Site Access: A stabilized stone surface at all points of ingress or egress to a project site, for the purpose of capturing and detaining sediment carried by tires of vehicles or other equipment entering or exiting the project site.

Contractor or Subcontractor: An individual or company hired by the project site or individual lot owner, their agent, or the individual lot operator to perform services on the project site.

Developer: Any person financially responsible for construction activity; or an owner of property who sells or leases, or offers for sale or lease, any lots in a subdivision.

Erosion: The detachment and movement of soil, sediment, or rock fragments by water, wind, ice, or gravity.

Erosion and Sediment Control Measure: A practice or a combination of practices, to control erosion and resulting sedimentation.

Erosion and Sediment Control System: The use of appropriate erosion and sediment control measures to minimize sedimentation by first reducing or eliminating erosion at the source and then as necessary, trapping sediment to prevent it from being discharged from or within a project site.

Final Stabilization:	The establishment of permanent vegetative cover or the application of a permanent non-erosive material to areas where all land disturbing activities have been completed and no additional land disturbing activities are planned under the current permit.
Grading:	The cutting and filling of the land surface to a desired slope or elevation.
Impervious Surface:	Surfaces, such as pavement and rooftops, which prevent the infiltration of storm water into the soil.
Individual Building Lot:	A single parcel of land within a multi-parcel development.
Individual Lot Operator:	A contractor or subcontractor working on an individual lot.
Individual Lot Owner:	A person who has financial control of construction activities for an individual lot.
Land-disturbing Activity:	Any manmade change of the land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting, and grading.
Measurable Storm Event:	A precipitation event that results in a total measured precipitation accumulation equal to, or greater than, one-half (0.5) inch of rainfall.
MS4 Area:	A land area comprising one (1) or more places that receives coverage under one (1) NPDES storm water permit regulated by 327 IAC 15-13 or 327 IAC 5-4-6(a)(3) and 327 IAC 5-4-6(a)(4).
MS4 Operator:	The person responsible for development, implementation, or enforcement of the minimum control measures for a designated MS4 area regulated under 327 IAC 15-13.
Peak Discharge:	The maximum rate of flow during a storm, usually in reference to a specific design storm event.
Permanent Stabilization:	The establishment, at a uniform density of seventy percent (70%) across the disturbed area, of vegetative cover or permanent non-erosive material that will ensure the resistance of the soil to erosion, sliding, or other movement.
Phasing of	Sequential development of smaller portions of a large project site,

Construction:	stabilizing each portion before beginning land disturbance on subsequent portions, to minimize exposure of disturbed land to erosion.
Project Site:	The entire area on which construction activity is to be performed.
Project Site Owner:	The person required to comply with the terms of this chapter, including either a developer or a person who has financial and operational control of construction activities, and project plans and specifications, including the ability to make modifications to those plans and specifications.
Sediment:	Solid material (both mineral and organic) that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface.
Sedimentation:	The settling and accumulation of unconsolidated sediment carried by storm water run-off.
Soil:	The unconsolidated mineral and organic material on the surface of the earth that serves as the natural medium for the growth of plants.
Stormwater Pollution Prevention Plan (SWPPP):	A plan developed to minimize the impact of storm water pollutants resulting from construction activities.
Stormwater Quality Measure:	A practice or a combination of practices, to control or minimize pollutants associated with storm water run-off.
Strip Development:	A multi-lot project where building lots front on an existing road.
Subdivision:	Any land that is divided or proposed to be divided into lots, whether contiguous or subject to zoning requirements, for the purpose of sale or lease as part of a larger common plan of development or sale.
Temporary Stabilization:	The covering of soil to ensure its resistance to erosion, sliding, or other movement. The term includes vegetative cover, anchored mulch, or other non-erosive material applied at a uniform density of seventy percent (70%) across the disturbed area.
Tracking:	The deposition of soil that is transported from one (1) location to another by tires, tracks of vehicles, or other equipment.

Trained Individual:	An individual who is trained and experienced in the principles of stormwater quality, including erosion and sediment control as may be demonstrated by state registration, professional certification (such as CESSWI, CPESC, and/or CISEC certification), or other documented and applicable experience or coursework as deemed sufficient by the City of Westfield that enable the individual to make judgments regarding stormwater control or treatment and monitoring.
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SECTION 03602 BASIC POLICIES AND PROCEDURES

03602.01 Applicability and Exemptions

The Westfield Public Works Department (WPWD) will require a Stormwater Pollution Prevention Plan (SWPPP), which includes erosion and sediment control measures and materials handling procedures, to be submitted as part of the construction plans and specifications. Any project located within the City of Westfield which falls under the jurisdictional authority of the City of Westfield and includes clearing, grading, excavation, and other land disturbing activities resulting in the disturbance of 1 acre or more of total land area is subject to the requirements of this Chapter. This includes both new development and re-development. This chapter also applies to disturbances of less than one 1 acre of land that are part of a larger common plan of development or sale if the larger common plan will ultimately disturb one (1) or more acres of land, within the area under the jurisdictional authority of the City of Westfield. Section 03602.03 of this Chapter provides guidelines for calculating land disturbance. Projects meeting the coverage requirements of 327 IAC 15-5 (Rule 5) shall also be in compliance with 327 IAC 15-5. It is the responsibility of the Developer/Project Engineer to ascertain any wetland delineations.

The requirements under this Chapter do not apply to the following activities:

1. agricultural land disturbing activities; or
2. forest harvesting activities.

The requirements under this Chapter do not apply to the following activities, provided other applicable State permits contain provisions requiring immediate implementation of soil erosion control measures:

1. Landfills that have been issued a certification of closure under 329 IAC 10.
2. Coal mining activities permitted under IC 14-34.
3. Municipal solid waste landfills that are accepting waste pursuant to a permit issued by the Indiana Department of Environmental Management under 329 IAC 10 that contains equivalent stormwater requirements, including the expansion of landfill boundaries and construction of new cells either within or outside the original solid waste permit boundary.

For an individual lot where land disturbance is expected to be one (1) acre or more, the individual lot owner must complete their own notice of intent letter, apply for a stormwater permit from the WPWD, and ensure that a sufficient construction and stormwater pollution prevention plan is completed and submitted in accordance with Chapter 03100; regardless of whether the individual lot is part of a larger permitted project site.

An individual lot with land disturbance less than one (1) acre, located within a larger permitted project site, is considered part of the larger permitted project site, and the

individual lot operator must comply with the terms and conditions of the stormwater permit approved for the larger project site. The stormwater permit application for the larger project site must include typical detailed erosion and sediment control measures for individual lots. Additionally, the individual lot operator or holder of an Improvement Location Permit Application is required to apply for an Erosion Control Inspection Permit Request per the Erosion & Sediment Control Inspection Ordinance for Individual Lots and Outlots. In addition, these individual lots are required to submit applications prior to receiving a building permit. Details of the permitting process are contained in Chapter 03100.

It will be the responsibility of the project site owner to complete a stormwater permit application and ensure that a sufficient construction plan is completed and submitted to the WPWD in accordance with Chapter 03100 of this Standard. It will be the responsibility of the project site owner to ensure compliance with the City of Westfield's applicable ordinances and standards during the construction activity and implementation of the construction plan, and to notify the WPWD with a sufficient notice of termination letter upon completion of the project and stabilization of the site. However, all persons engaging in construction and land disturbing activities on a permitted project site must comply with the requirements of this Chapter and the City of Westfield's applicable ordinances.

03602.02
Policy on
Stormwater Pollution
Prevention

Effective stormwater pollution prevention on construction sites is dependent on a combination of preventing movement of soil from its original position (erosion control), intercepting displaced soil prior to entering a waterbody (sediment control), and proper on-site materials handling. The developer must submit to the WPWD a SWPPP with detailed erosion and sediment control plans as well as a narrative describing materials handling and storage, and construction sequencing. The following principles apply to all land-disturbing activities and should be considered in the preparation of a Stormwater Pollution Prevention Plan within the City of Westfield.

1. Minimize the potential for soil erosion by designing a development that fits the topography and soils of the site. Deep cuts and fills in areas with steep slopes should be avoided wherever possible, and natural contours should be followed as closely as possible.
2. Existing natural vegetation should be retained and protected wherever possible. Areas immediately adjacent (within 35 feet of top of bank) to watercourses and lakes also should be left undisturbed wherever possible. Unvegetated or vegetated areas with less than 70% cover that are scheduled or likely to be left inactive for 15 days or more must be temporarily or permanently stabilized with measures appropriate for the season to reduce erosion potential. Alternative measures to site stabilization may be acceptable if the project site owner or their representative can demonstrate they have implemented and maintained erosion and sediment control measures adequate to prevent sediment discharge from the inactive area.
3. All activities on a site should be conducted in a logical sequence so that the smallest practical area of land will be exposed for the shortest practical period of time during development.
4. The length and steepness of designed slopes should be minimized to reduce erosion potential. Drainage channels and swales must be designed and adequately protected so that their final gradients and resultant velocities

will not cause erosion in the receiving channel or at the outlet. Methods for determining acceptable velocities are included in these Standards.

5. Sediment-laden water which otherwise would flow from the project site shall be treated by erosion and sediment control measures appropriate to minimize sedimentation. A stable construction site access shall be provided at all points of construction traffic ingress and egress to the project site.
6. Appropriate measures shall be implemented to prevent wastes or unused building materials, including, garbage, debris, packaging material, fuels and petroleum products, hazardous materials or wastes, cleaning wastes, wastewater, concrete truck washout, and other substances from being carried from a project site by runoff or wind. Identification of areas where concrete truck washout is permissible must be clearly posted at appropriate areas of the site. Wastes and unused building materials shall be managed and disposed of in accordance with all applicable State statutes and regulations. Proper storage and handling of materials such as fuels or hazardous wastes, and spill prevention and cleanup measures (including having spill response equipment on-site) shall be implemented to minimize the potential for pollutants to contaminate surface or ground water or degrade soil quality.
7. Public or private roadways shall be kept cleared of accumulated sediment that is a result of runoff or tracking. Bulk clearing of accumulated sediment shall not include flushing the area with water. Cleared sediment shall be redistributed or disposed of in a manner that is in accordance with all applicable statutes and regulations.
8. Collected runoff leaving a project site must be either discharged directly into a well-defined, stable receiving channel, or diffused and released to adjacent property without causing an erosion or pollutant problem to the adjacent property owner.
9. Natural features, including wetlands, shall be protected from pollutants associated with stormwater runoff.

03602.03
Calculating
Total Area of
Land

In calculating the total area of land disturbance, for the purposes of determining applicability of this Chapter to the project, the following guidelines should be used:

1. Off-site construction activities that provide services (for example, road extensions, sewer, water, and other utilities) to a land disturbing project site, must be considered as a part of the total land disturbance calculation for the project site, when the activity is under the control of the project site owner.
2. Strip developments will be considered as one (1) project site and must comply with this Chapter unless the total combined disturbance on all individual lots is less than one (1) acre and is not part of a larger common plan of development or sale.
3. To determine if multi-lot project sites are regulated by the City of Westfield, the area of land disturbance shall be calculated by adding the total area of land disturbance for improvements, such as, roads, utilities, or common areas, and the expected total disturbance on each individual lot, as determined by the following:

- a. For a single-family residential project site where the lots are one-half (0.5) acre or more, one-half (0.5) acre of land disturbance must be used as the expected lot disturbance.
- b. For a single-family residential project site where the lots are less than one half (0.5) acre in size, the total lot must be calculated as being disturbed.
- c. To calculate lot disturbance on all other types of projects sites, such as industrial and commercial projects project sites, a minimum of one (1) acre of land disturbance must be used as the expected lot disturbance, unless the lots are less than one (1) acre in size, in which case the total lot must be calculated as being disturbed.

03602.04
Common Erosion
and Sediment
Control Practices

All erosion control and stormwater pollution prevention measures required to comply with the City of Westfield's Ordinance shall meet the design criteria, standards, and specifications similar to or the same as those outlined in the latest editions of the "Indiana Drainage Handbook" and "Indiana Handbook for Erosion Control in Developing Areas", both published by the Indiana Department of Natural Resources, or other comparable and reputable references. Table 03602-1 lists some of the more common and effective practices for preventing stormwater pollution from construction sites. Details of each practice can be found in the Indiana Drainage Handbook, the Indiana Handbook for Erosion Control in Developing Areas, or in Appendix 03602-1. These practices should be used to protect *every* potential pollution pathway to stormwater conveyances.

03602.05
Individual Lot
Controls

From the time construction on an individual lot begins, until the individual lot is stabilized, the builder must take steps to:

- protect adjacent properties from sedimentation
- prevent mud/sediment from depositing on the street
- protect drainageways from erosion and sedimentation
- prevent sediment laden water from entering storm sewer inlets

A generic erosion control plan for individual lots is provided as Exhibit 03602-1. A typical plan should include perimeter silt fence, stabilized construction entrance, curb inlet protection, drop inlet protection, stockpile containment, stabilized drainage swales, downspout extensions, temporary seeding and mulching, and permanent vegetation. Every relevant measure shall be installed at each individual lot site.

Construction sequence on individual lots should be as follows:

1. Clearly delineate areas of trees, shrubs, and vegetation that are to be undisturbed. To prevent root damage, the areas delineated for tree protection should be at least the same diameter as the crown.
2. Install perimeter silt fence at construction limits. Position the fence to intercept runoff prior to entering drainage swales.
3. Avoid disturbing drainage swales if vegetation is established. If drainage swales are bare, install erosion control blankets or sod to immediately stabilize.
4. Install drop inlet protection for all inlets on the property.

5. Install curb inlet protection, on both sides of the road, for all inlets along the property frontage and along the frontage of adjacent lots, or install temporary catch basin inserts in each inlet and frequently clean.
6. Install gravel construction entrance that extends from the street to the building pad.
7. Perform primary grading operations.
8. Contain erosion from any soil stockpiles created on-site with silt fence around the base.
9. Establish temporary seeding and straw mulch on disturbed areas.
10. Construct the home and install utilities.
11. Install downspout extenders once the roof and gutters have been constructed. Extenders should outlet to a stabilized area.
12. Re-seed any areas disturbed by construction and utilities installation with temporary seed mix within 3 days of completion of disturbance.
13. Grade the site to final elevations. Add topsoil as needed to minimize erosion of underlying soil and to quickly establish grass.
14. Install permanent seeding or sod.

All erosion and sediment control measures must be properly maintained throughout construction. Temporary and permanent seeding should be watered as needed until established. For further information on individual lot erosion and sediment control, please see the "Individual Lot Erosion and Sediment Control Plan and Certification" form in Exhibit 03602-1 or the IDNR, Division of Soil Conservation's pamphlet titled "Erosion and Sediment Control for Individual Building Sites".

03602.06
Inspection,
Maintenance,
Record Keeping,
and Reporting

Following approval of the Rule 5 Notice of Intent by IDEM and commencement of construction activities, the WPWD has the authority to conduct inspections of the site to ensure full compliance with the provisions of this Chapter, the most current edition of the Indiana Stormwater Quality Manual, and the terms and conditions of the approved permit.

A self-monitoring program must be implemented and logged by the project site owner to ensure the Stormwater Pollution Prevention Plan is working effectively. A trained individual, acceptable by the WPWD, shall perform a written evaluation of the project site by the end of the next business day following each measurable storm event of 0.5 inches or more. If there are no measurable storm events within a given week, the site should be monitored at least once in that week. Weekly inspections by the trained individual shall continue until the entire site has been stabilized and a "verified" copy of the Notice of Termination has been issued. The trained individual should look at the maintenance of existing stormwater pollution prevention measures, including erosion and sediment control measures, drainage structures, and construction materials storage/containment facilities, to ensure they are functioning properly. The trained individual should also identify additional measures, beyond those originally identified in the stormwater pollution prevention plan, necessary to remain in compliance with all applicable statutes and regulations. A standard form to record the self-monitoring/inspection results is provided as Exhibit 03602-2.

The resulting maintenance evaluation reports must include the name of the individual performing the evaluation, the date of the evaluation, problems identified at the project site, and details of maintenance, additional measures, and corrective actions recommended and completed.

The Stormwater Pollution Prevention Plan shall serve as a guideline for stormwater quality, but should not be interpreted to be the only basis for implementation of stormwater quality measures for a project site. The project site owner is responsible for implementing, in accordance with this Chapter, all measures necessary to adequately prevent polluted stormwater runoff. Recommendations by the trained individual for modified stormwater quality measures should be implemented.

Although self-monitoring reports do not need to be submitted to the WPWD, the WPWD has the right to request complete records of maintenance and monitoring activities involving stormwater pollution prevention measures. All evaluation reports for the project site must be made available to the WPWD, in an organized fashion, within forty-eight (48) hours upon request.

TABLE 03602-1: Common Stormwater Pollution Control Practices for Construction Sites

Practice No.	BMP Description	Applicability	Fact Sheet
1	Site Assessment	All sites	2
2	Construction Sequencing	All sites	CN-101
3	Tree Preservation and Protection	Nearly all sites	1
4	Temporary Gravel Construction Entrance Pad	All sites	1
5	Wheel Wash	All sites	CN-102
6	Silt Fence	All sites	1
7	Surface Roughening	Sites with slopes that are to be stabilized with vegetation	1
8	Temporary Seeding	Areas of bare soil where additional work is not scheduled to be performed for a minimum of 15 days	1
9	Mulching	Temporary surface stabilization	1
10	Erosion Control Blanket (Surface)	Temporary surface stabilization, anchor for mulch	1
11	Temporary Diversion	Up-slope and down-slope sides of construction site, above disturbed slopes within construction site	1
12	Rock Check Dam	2 acres maximum contributing to drainage area	1
13	Temporary Slope Drain	Sites with cut or fill slopes	1
14	Straw Bale Dam	Small drainage areas	1
15	Drop Basket Inlet Protection	1 acre maximum contributing drainage area	1
16	Basket Curb Inlet Protection	1 acre maximum contributing drainage area	1
17	Sandbag Curb Inlet Protection	1 acre maximum contributing Drainage area	1
18	Temporary Sediment Trap	5 acre maximum contributing Drainage area	1
19	Temporary Sediment Basin	30 acre maximum contributing Drainage area	1
20	Dewatering Structure	Sites requiring dewatering	CN-103
21	Dust Control	All sites	1
22	Spill Prevention and Control	All sites	CN-104
23	Solid Waste Management	All sites	CN-105
24	Hazardous Waste Management	All sites	CN-106

Fact sheet Location:

1. Indiana Handbook for Erosion Control in Developing Areas, 1992 or later
2. Indiana Drainage Handbook, 1999 or later

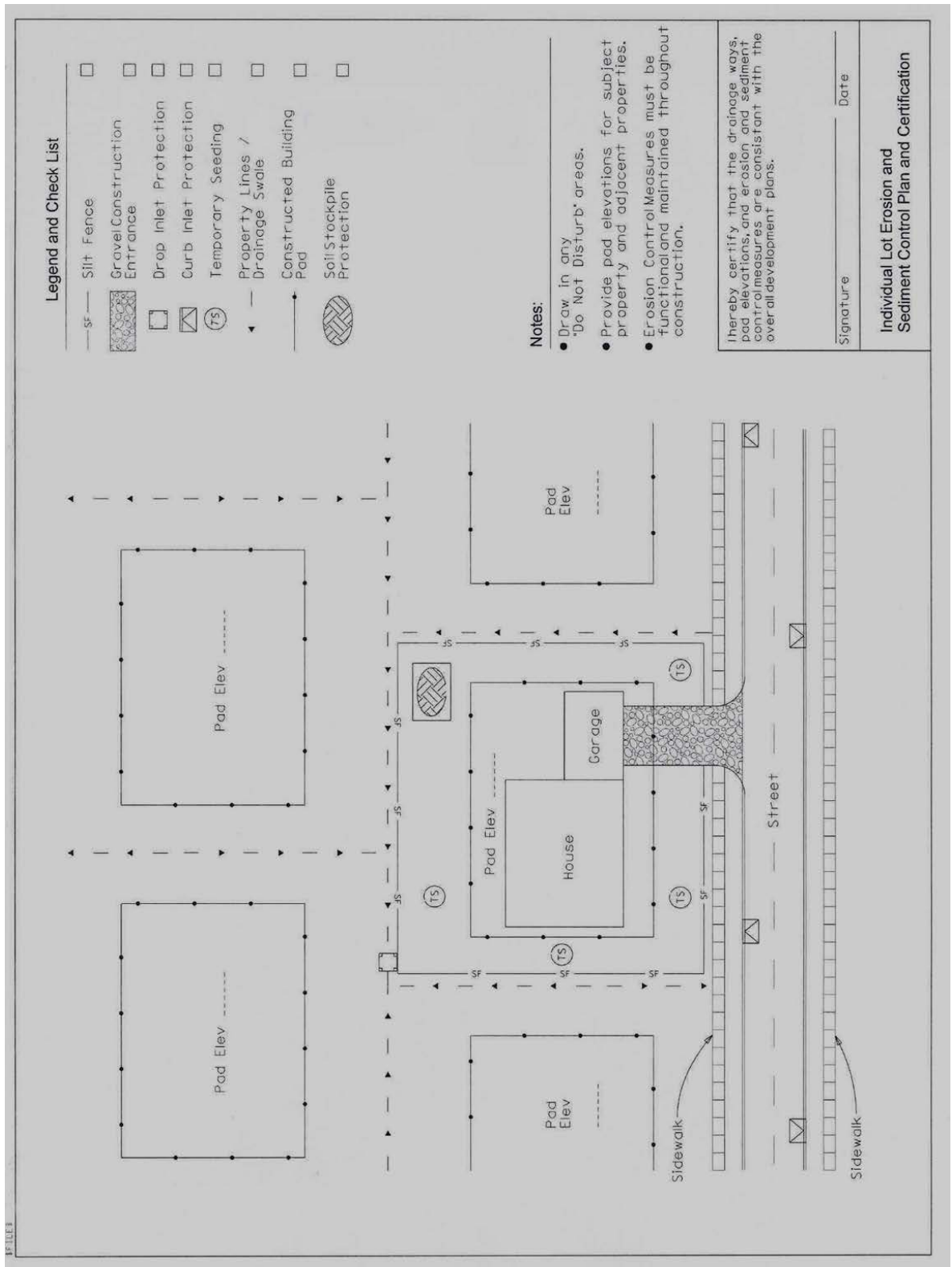


Exhibit 03602-1: Individual Lot Typical Erosion & Sediment Control Plan and Certification

Exhibit 03602-2: Construction Site Inspection And Maintenance Log

Date: _____

Project: _____

Inspected by: _____

Type of Inspection: ☐ Scheduled Weekly ☐ Rain Event**CONSTRUCTION SITE INSPECTION AND MAINTENANCE LOG
(To be Completed by Property Owner or Agent)**

All stormwater pollution prevention BMPs shall be inspected and maintained as needed to ensure continued performance of their intended function during construction and shall continue until the entire site has been stabilized and a Notice of Termination has been issued. An inspection of the project site must be completed by the end of the next business day following each measurable storm event. If there are no measurable storm events within a given week, the site should be monitored at least once in that week. Maintenance and repair shall be conducted in accordance with the accepted site plans. This log shall be kept as a permanent record and must be made available to the WPWD in an organized fashion, within forty-eight (48) hours upon request.

YES	NO	N/A		
			1	Is the site information posted at the entrance?
			2	Are all necessary permits attained and special provisions being implemented?
			3	Is a construction entrance installed and functioning properly?
			4	Are construction staging & parking areas restricted to areas designated on the plans?
			5	Are public and private streets clean of sediment, debris and mud?
			6	Are appropriate practices installed where stormwater leaves the site?
			7	Are all discharge points (outfalls) free of erosion or sediment transport?
			8	Has all silt fence been installed properly and being maintained? (entrenched - upright - fabric not torn - terminated to higher ground - properly joined at ends)
			9	Are sediment basins & traps installed according to plan & pipe or rock spillways functional?
			10	Are other sediment control barriers in place and functioning properly?
			11	Is the earthwork for erosion control practices properly graded, seeded and/or mulched?
			12	Are diversion swales and/or waterbars installed to plan & protected?
			13	Do perimeter practices have adequate capacity & do they need to be cleaned out?
			14	Is inlet protection installed properly on all functioning inlets & being maintained?
			15	Is catch basin insert protection installed where required & being maintained?
			16	Have swales and ditches been stabilized or protected?
			17	Are stormwater outlets adequately stabilized?
			18	Has temporary stabilization of disturbed ground been addressed? (dormant for 15 days?)
			19	Is permanent stabilization of disturbed ground progressing on all completed areas?
			20	Has hard or soft armoring been installed where natural vegetation will erode?
			21	Do water pumping operations have a protected outlet and discharge clear water?
			22	Are all dewatering structures functioning properly?
			23	Is a designated equipment washout area established, clearly marked and being utilized?
			24	Is solid waste properly contained & a stable access provided to the storage & pickup area?
			25	Are fuel tanks and other hazardous materials safely stored and protected?
			26	Is spill response equipment on-site and easily accessible?
			27	Are temporary soil stockpiles in approved areas & properly protected?

Date: _____

Inspected by: _____

If you answered "no" to any of the above questions, describe any corrective action which must be taken to remedy the problem and when the corrective actions are to be completed.

[illegible]

APPENDIX 03602-1

CONSTRUCTION BMP FACT SHEETS

BMP CN – 101

CONSTRUCTION SEQUENCING

DESCRIPTION

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided. Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

ADVANTAGES

1. Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing, provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

DESIGN CRITERIA

1. Avoid rainy periods.
2. Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to vegetate cut and fill slopes as the work progresses.

REFERENCE

City of Tacoma, Surface Water Management Manual, 2003 or later

BMP CN – 102 WHEEL WASH

DESCRIPTION

When a stabilized construction entrance is not preventing sediment from being tracked onto pavement, a wheel wash may be installed. Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street. Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.

ADVANTAGES

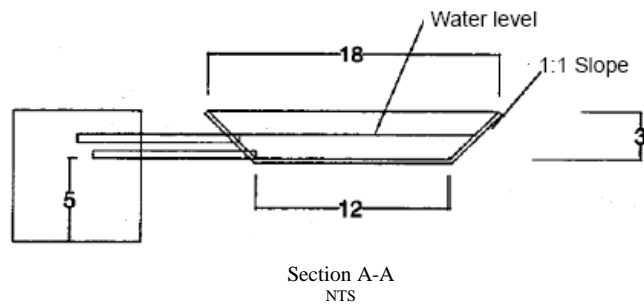
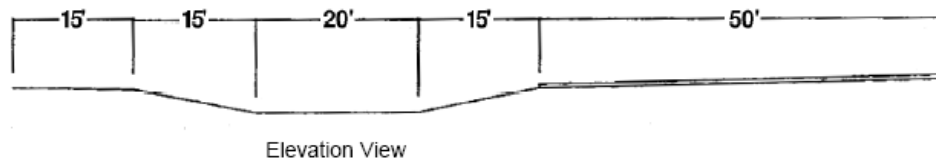
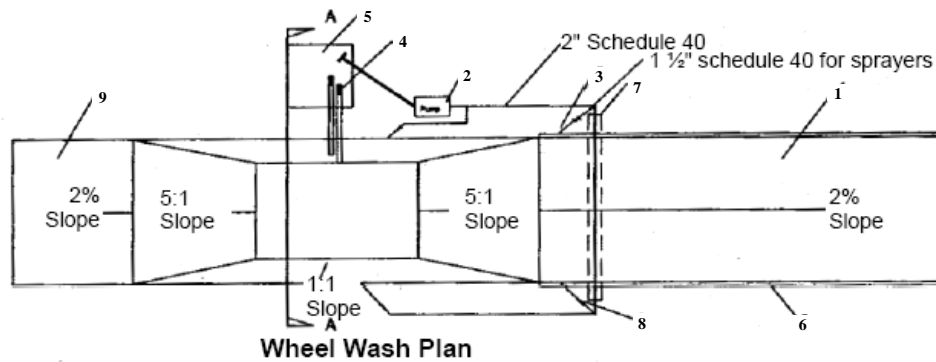
1. Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

DESIGN CRITERIA

1. Suggested details are shown in Figure CN-102-A. The City of Westfield may allow other designs.
2. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.
3. Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.
4. Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.
5. Midpoint spray nozzles are only needed in extremely muddy conditions.
6. Wheel wash systems should be designed with a small grade change, 6 to 12 inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment.
7. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling.
8. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time.
9. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.
10. The wheel wash should start out the day with fresh water. The wash water should be changed a minimum of once per day.
11. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.
12. Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system, such as closed-loop recirculation or land application, or to the sanitary sewer with proper local sewer utility approval.

REFERENCE

City of Tacoma, Surface Water Management Manual, 2003 or later



Notes:

1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so can be cleaned with trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

Figure CN-102-A

BMP CN – 103

DEWATERING STRUCTURE

DESCRIPTION

Water which is pumped from a construction site usually contains a large amount of sediment. A dewatering structure is designed to remove the sediment before water is released off-site.

This practice includes several types of dewatering structures which have different applications dependent upon site conditions and types of operation. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the WPWD.

DESIGN CRITERIA

1. A dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure.
2. Material from any required excavation shall be stored in an area and protected in a manner that will prevent sediments from eroding and moving off-site.
3. An excavated basin (applicable to “Straw Bale/Silt Fence Pit”) may be lined with filter fabric to help reduce scour and to prevent the inclusion of soil from within the structure.
4. Design criteria more specific to each particular dewatering device can be found in Figures CN-103-A through CN-103-C.
5. A dewatering structure may not be needed if there is a well-stabilized, vegetated area onsite to which water may be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. A minimum filtering length of 75 feet must be available in order for such a method to be feasible.
6. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed.
7. The accumulated sediment which is removed from a dewatering device must be spread on-site and stabilized or disposed of at an approved disposal site as per approved plan.

Portable Sediment Tank (see Figure CN103-A)

- The structure may be constructed with steel drums, sturdy wood or other material suitable for handling the pressure exerted by the volume of water.
- Sediment tanks will have a minimum depth of 2 ft.
- The sediment tank shall be located for easy clean-out and disposal of the trapped sediment and to minimize the interference with construction activities.
- The following formula shall be used to determine the storage volume of the sediment tank:

$$\text{Pump discharge (gallons/min.)} \times 16 = \text{cubic feet of storage required}$$

- Once the water level nears the top of the tank, the pump must be shut off while the tank drains and additional capacity is made available.
- The tank shall be designed to allow for emergency flow over top of the tank. Clean-out of the tank is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

Filter Box (see Figure CN-103-B)

- The box selected should be made of steel, sturdy wood or other materials suitable to handle the pressure requirements imposed by the volume of water. Normally readily available 55 gallon drums welded top to bottom will suffice in most cases.
- Bottom of the box shall be made porous by drilling holes (or some other method).
- Coarse aggregate shall be placed over the holes at a minimum depth of 12 inches, metal “hardware” cloth may need to be placed between the aggregate and the holes if holes are drilled larger than the majority of the stone.
- As a result of the fast rate of flow of sediment-laden water through the aggregate, the effluent must be directed over a well-vegetated strip of at least 50 feet after leaving the base of the filter box.
- The box shall be sized as follows:

$$\text{Pump discharge (gallons/min.)} \times 16 = \text{cubic feet of storage required}$$

- Once the water level nears the top of the box, the pump must be shut off while the box drains and additional capacity is made available.
- The box shall be designed/constructed to allow for emergency flow over the top of this box.
- Clean-out of the box is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.
- If the stone filter does become clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned and replaced.
- Using a filter box only allows for minimal settling time for sediment particles; therefore, it should only be used when site conditions restrict the use of the other methods.

Straw Bale/Silt Fence Pit (see Figure CN-103-C)

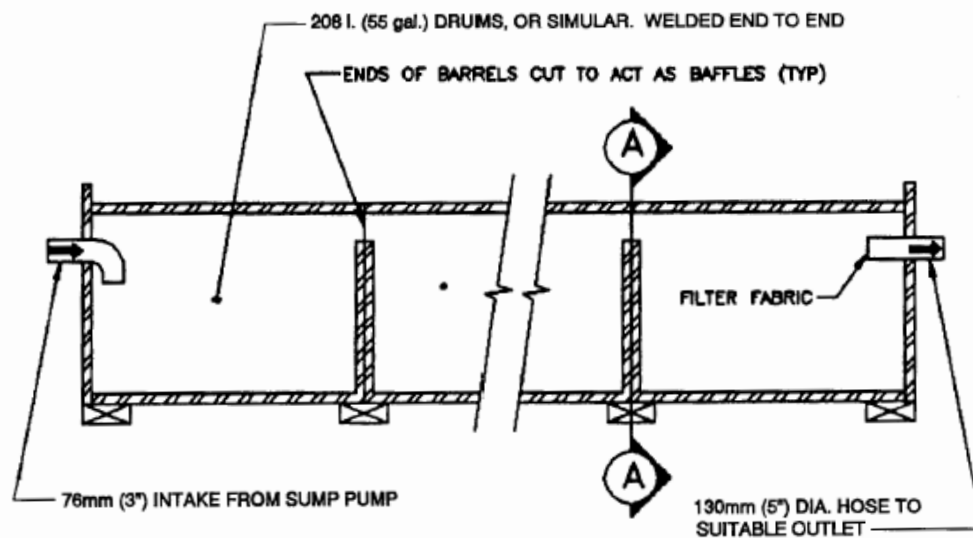
- Measure shall consist of straw bales, silt fence, a stone outlet (a combination of riprap and aggregate) and a wet storage pit oriented as shown in Figure CN-103-C.
- The structure must have a capacity which is dictated by the following formula:

$$\text{Pump discharge (gallons/min.)} \times 16 = \text{cubic feet of storage required}$$

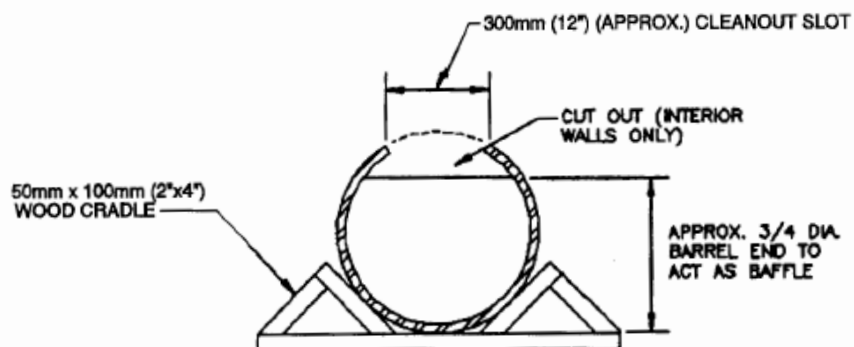
- In calculating the capacity, one should include the volume available from the floor of the excavation to the crest of the stone weir.
- In any case, the excavated area should be a minimum of 3 feet below the base of the perimeter measures (straw bales or silt fence).
- The perimeter measures must be installed as per the guidelines found in fact sheets associated with STRAW BALE BARRIER and SILT FENCE BMPs.
- Once the water level nears the crest of the stone weir (emergency overflow), the pump must be shut off while the structure drains down to the elevation of the wet storage.
- The wet storage pit may be dewatered only after a minimum of 6 hours of sediment settling time. This effluent should be pumped across a well vegetated area or through a silt fence prior to entering a watercourse.
- Once the wet storage area becomes filled to one-half of the, excavated depth, accumulated sediment shall be removed and properly disposed of.
- Once the device has been removed, ground contours will be returned to original condition.

REFERENCE

United States Army Corps of Engineers, Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities, 1997 or later

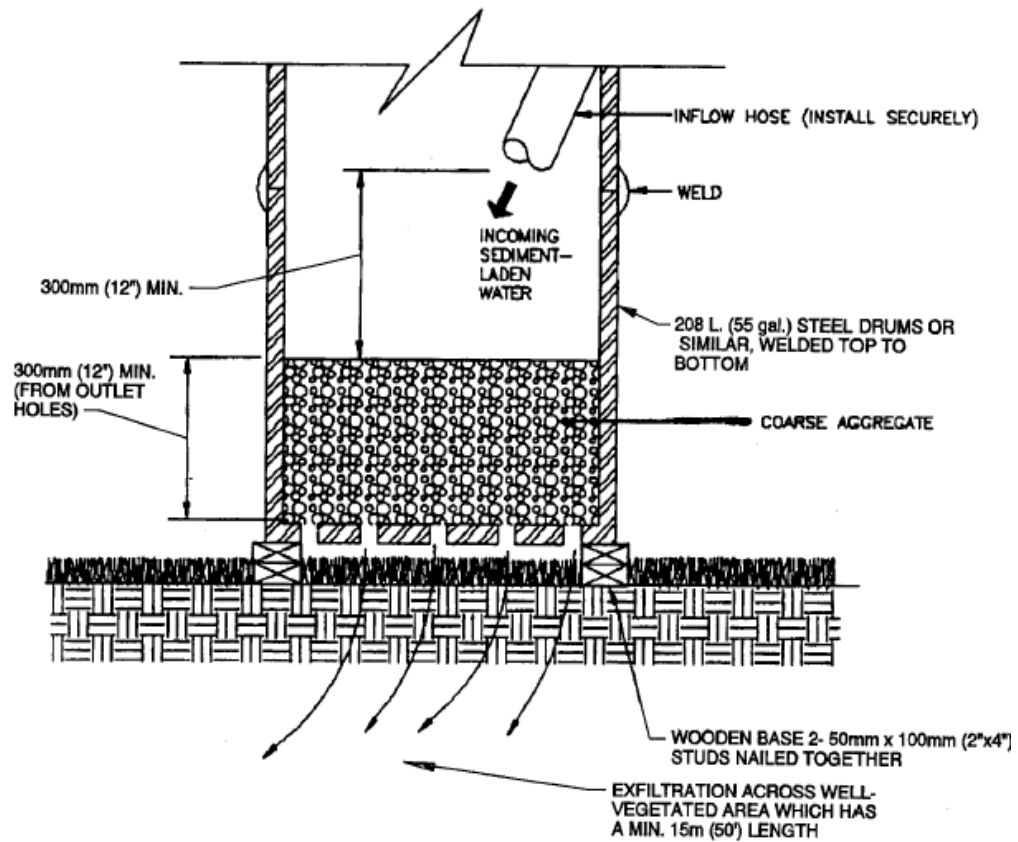


ELEVATION



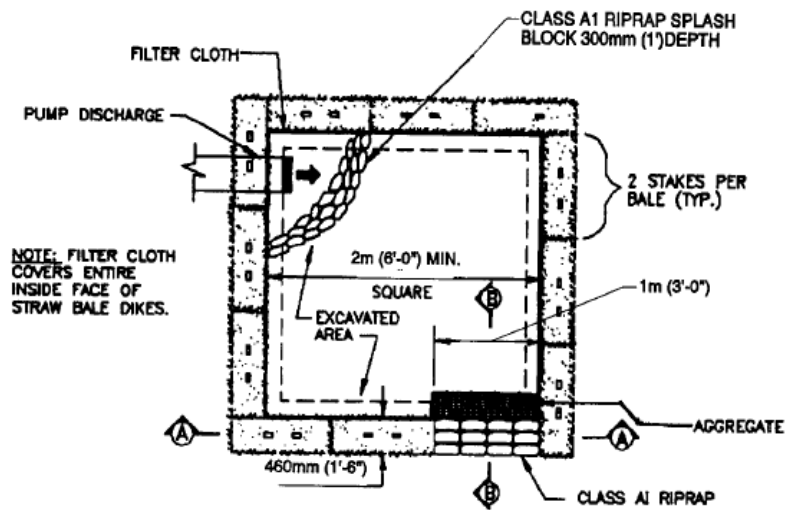
CROSS-SECTION A-A

Figure CN-103-A
Portable Sediment Tank

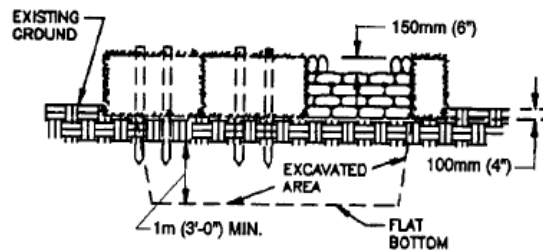


ELEVATION VIEW

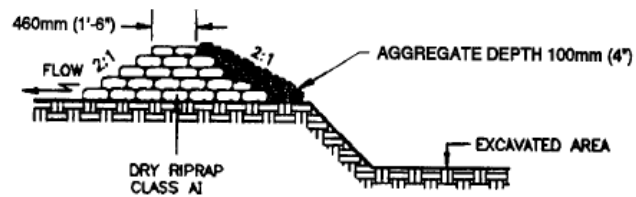
Figure CN-103-B
Filter Box



PLAN VIEW



CROSS-SECTION A-A



CROSS-SECTION B-B

Figure CN-103-C
Straw Bale/Silt Fence Pit

BMP CN – 104

SPILL PREVENTION AND CONTROL

DESCRIPTION

These procedures and practices are implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses.

This best management practice (BMP) applies to all construction projects. Spill control procedures are implemented anytime chemicals and/or hazardous substances are stored. Substances may include, but are not limited to:

- Soil stabilizers/binders
- Dust Palliatives
- Solvents
- Herbicides
- Paper
- Plastic
- Growth inhibitors
- Fertilizers
- Concrete washout
- Deicing/anti-icing chemicals
- Fuels
- Lubricants
- Solid wastes
- Other petroleum distillates

To the extent that the work can be accomplished safely, spills of oil, petroleum products, sanitary and septic wastes, and substances listed under 40 Code of Federal Regulations (CFR) parts 110, 117, and 302 shall be contained and cleaned up immediately.

LIMITATIONS

1. The contractor/owner shall maintain a list of qualified contractors, Vac-trucks, tank pumpers and other equipment or businesses qualified to do clean-up operations.
2. Procedures and practices presented in this BMP are general. Contractor shall identify appropriate practices for the specific materials used or stored on-site and in sufficient quantities in advance of their arrival at the site.
3. All employees need to be educated on the proper application of the absorbent materials and there purpose.
4. All maintenance and equipment operators must be aware and trained for prevention of spills. A continuing education program should be required for new employees.
5. All materials used in the course of cleanup should be disposed of in a manor approved by the Indiana Department of Environmental Management.
6. Using water to flush spilled material will not be permitted unless authorized by The City of Westfield. Tarps can be used to cover spills during rain events.

DESIGN CRITERIA

1. To the extent that it doesn't compromise cleanup activities, spills shall be covered and protected from stormwater runoff during rainfall.
2. Spills shall not be buried or washed with water.
3. Used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose shall be stored and disposed of in conformance with BMP CN-106: Hazardous Waste Management.

4. Water used for cleaning and decontamination shall not be allowed to enter storm drains or watercourses and shall be collected and disposed of in accordance with BMP CN-106: Hazardous Waste Management.
5. Water overflow or minor water spillage shall be contained and shall not be allowed to discharge into drainage facilities or watercourses.
6. Proper storage, clean-up and spill reporting instruction for hazardous materials stored or used on the project site shall be posted at all times in an open, conspicuous and accessible location.
7. Waste storage areas shall be kept clean, well-organized and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners shall be repaired or replaced as needed to maintain proper function.
8. Verify weekly that spill control and clean up materials are located near material storage, unloading, and use areas.
9. Update spill prevention and control plans and stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored onsite.

Cleanup and Storage Procedures for Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc., which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Remove the absorbent materials promptly and dispose of properly.
- The practice commonly followed for a minor spill is:
 - Contain the spread of the spill.
 - Recover spilled materials.
 - Clean the contaminated area and/or properly dispose of contaminated materials.

Cleanup and Storage Procedures for Semi-Significant Spills

- Approximately ten gallons or less of pollutant with no contamination of ground or surface waters. Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.
- Clean up spills immediately:
- Notify the project foreman immediately. The foreman shall notify the City of Westfield Emergency Management Agency's Hazardous Materials Response Team.
- Contain spread of the spill.
- If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
- If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
- If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Cleanup and Storage Procedures for Significant/Hazardous Spills

- More than ten gallons, there is the potential for death, injury or illness to humans or animals or has the potential for surface or groundwater pollution. For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.

- For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor shall notify the National Response Center at (800) 424-8802.
- Notification shall first be made by telephone and followed up with a written report.
- The services of a spills contractor or a Haz-Mat team shall be obtained immediately. Construction personnel shall not attempt to clean up the spill until the appropriate and qualified personnel have arrived at the job site.
- As soon as possible but within 2 hours of discovery, contact the Department of Environmental Management, Office of Emergency Response 1-888-233-7745. The following information should be noted for future reports to IDEM or the National Response Center.
 - Name, address and phone number of person making the spill report
 - The location of the spill
 - Identification of the spilled substance
 - Approximate quantity of the substance that has been spilled or may be further spilled
 - The duration and source of the spill
 - Name and location of the damaged waters
 - Name of spill response organization
 - What measures were taken in the spill response
 - Other information that may be significant

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later

BMP CN – 105

SOLID WASTE MANAGEMENT

DESCRIPTION

Solid waste management procedures and practices are designed to minimize or eliminate the discharge of pollutants to the drainage system or to watercourses as a result of the creation, stockpiling, or removal of construction site wastes.

Solid waste management procedures and practices are implemented on all construction projects that generate solid wastes.

Solid wastes include but are not limited to:

1. Construction wastes including brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials.
2. Landscaping wastes, including vegetative material, plant containers, and packaging materials.
3. Litter, including food containers, beverage cans, coffee cups, paper bags, plastic wrappers, and smoking materials, including litter generated by the public.

LIMITATIONS

1. Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season.

DESIGN CRITERIA

1. Dumpsters of sufficient size and number shall be provided to contain the solid waste generated by the project and properly serviced.
2. Littering on the project site shall be prohibited.
3. To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines shall be a priority.
4. Trash receptacles with lids shall be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
5. Construction debris and litter from work areas within the construction limits of the project site shall be collected and placed in watertight dumpsters at least weekly regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris shall not be placed in or next to drain inlets, storm water drainage systems or watercourses.
6. Full dumpsters shall be removed from the project site and the contents shall be disposed of, off-site, in an appropriate manner.
7. Litter stored in collection areas and containers shall be handled and disposed of by trash hauling contractors.
8. Construction debris and waste shall be removed from the site weekly.
9. Stormwater run-off shall be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
10. Solid waste storage areas shall be located at least 50 ft from drainage facilities and watercourses and shall not be located in areas prone to flooding or ponding.

11. Except during fair weather, construction and landscaping waste not stored in watertight dumpsters shall be securely covered from wind and rain by covering the waste with tarps, plastic sheeting, or equivalent.
12. Dumpster washout on the project site is not allowed.
13. Notify trash hauling contractors that only watertight dumpsters are acceptable for use on-site.
14. Plan for additional containers during the demolition phase of construction.
15. Plan for more frequent pickup during the demolition phase of construction.
16. Construction waste shall be stored in a designated area. Access to the designated area shall either be well vegetated ground, a concrete or asphalt road or drive, or a gravel construction entrance, to avoid mud tracking by trash hauling contractors.
17. Segregate potentially hazardous waste from non-hazardous construction site waste.
18. Keep the site clean of litter debris.
19. Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
20. For disposal of hazardous waste, see BMP CN-106: Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
21. Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.
22. Prohibit littering by employees, subcontractors, and visitors.
23. Wherever possible, minimize production of solid waste materials.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later

BMP CN – 106

HAZARDOUS WASTE MANAGEMENT

DESCRIPTION

These are procedures and practices to minimize or eliminate the discharge of pollutants from construction site hazardous waste to the storm drain systems or to watercourses.

This best management practice (BMP) applies to all construction projects.

Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products,
- Asphalt Products,
- Concrete Curing Compounds,
- Pesticides,
- Acids,
- Paints,
- Stains,
- Solvents,
- Wood Preservatives,
- Roofing Tar, or
- Any materials deemed a hazardous waste in 40 CFR Parts 110, 117, 261, or 302.

DESIGN CRITERIA

Storage Procedures

1. Wastes shall be stored in sealed containers constructed of a suitable material and shall be labeled as required by 49 CFR Parts 172, 173, 178, and 179.
2. All hazardous waste shall be stored, transported, and disposed as required in 49 CFR 261-263.
3. Waste containers shall be stored in temporary containment facilities that shall comply with the following requirements:
 - Temporary containment facility shall provide for a spill containment volume able to contain precipitation from a 24-hour, 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
 - Temporary containment facility shall be impervious to the materials stored there for a minimum contact time of 72 hours.
 - Temporary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks accumulated rainwater and spills shall be placed into drums after each rainfall. These liquids shall be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids shall be sent to an approved disposal site.
 - Sufficient separation shall be provided between stored containers to allow for spill cleanup and emergency response access.
 - Incompatible materials, such as chlorine and ammonia, shall not be stored in the same temporary containment facility.

- Throughout the rainy season, temporary containment facilities shall be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs. A storage facility having a solid cover and sides is preferred to a temporary tarp. Storage facilities shall be equipped with adequate ventilation.
4. Drums shall not be overfilled and wastes shall not be mixed.
 5. Unless watertight, containers of dry waste shall be stored on pallets.
 6. Paint brushes and equipment for water and oil based paints shall be cleaned within a contained area and shall not be allowed to contaminate site soils, watercourses or drainage systems. Waste paints, thinners, solvents, residues, and sludge that cannot be recycled or reused shall be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths shall be disposed of as solid waste.
 7. Ensure that adequate hazardous waste storage volume is available.
 8. Ensure that hazardous waste collection containers are conveniently located.
 9. Designate hazardous waste storage areas on site away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
 10. Minimize production or generation of hazardous materials and hazardous waste on the job site.
 11. Use containment berms in fueling and maintenance areas and where the potential for spills is high.
 12. Segregate potentially hazardous waste from non-hazardous construction site debris.
 13. Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
 14. Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
 15. Place hazardous waste containers in secondary containment.
 16. Do not allow potentially hazardous waste materials to accumulate on the ground.
 17. Do not mix wastes.

Disposal Procedures

1. Waste shall be removed from the site within 90 days of being generated.
2. Waste shall be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
3. A certified laboratory shall sample waste and classify it to determine the appropriate disposal facility.
4. Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for solid waste construction debris.
5. Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
6. Recycle any useful material such as used oil or water-based paint when practical.

Maintenance and Inspection

1. A foreman and/or construction supervisor shall monitor on-site hazardous waste storage and disposal procedures.
2. Waste storage areas shall be kept clean, well organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.

3. Storage areas shall be inspected in conformance with the provisions in the contract documents.
4. Perimeter controls, containment structures, covers, and liners shall be repaired or replaced as needed to maintain proper function.
5. Hazardous spills shall be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
6. The National Response Center, at (800) 424-8802, shall be notified of spills of Federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302.
7. Copy of the hazardous waste manifests shall be provided to the owner.

REFERENCE

California Department of Transportation, Construction Site BMP Manual, 2000 or later

CHAPTER 03700: POST-CONSTRUCTION STORMWATER QUALITY MANAGEMENT

SECTION 03701 INTRODUCTION

03701.01 Purpose and Background

It is recognized that developed areas, as compared to undeveloped areas, generally have increased imperviousness, decreased infiltration rates, increased runoff rates, and increased concentrations of pollutants such as fertilizers, herbicides, greases, oil, salts and other pollutants. As new development and re-development continues within the corporate boundaries of the City of Westfield, measures must be taken to intercept and filter pollutants from stormwater runoff prior to reaching regional creeks, streams, and rivers. Through the use of appropriate Best Management Practices (BMPs), stormwater runoff will be filtered and harmful amounts of sediment, nutrients, and contaminants will be removed.

It is also recognized that another major source of pollution in many Indiana streams, including those within the corporate boundaries of the City of Westfield, is the streambank erosion associated with urbanizing watersheds. Stream channels develop their shape in response to the volume and rate of runoff that they receive from their contributing watersheds. Research has shown that in hydrologically stable watersheds, the stream flow responsible for most of the shaping of the channel (called the bankfull flow) occurs between every one to two years. When land is developed, the volume and rate of runoff from that land increases for these comparatively small flooding events that are not normally addressed by the detention practices and the stream channel will adapt by changing its shape. As the stream channel works to reach a new stable shape, excess erosion occurs. As new development and re-development continues within the corporate boundaries of the City of Westfield, measures must be taken to minimize the impact of such development or re-development on streambank erosion. Through the use of appropriate BMPs, the volume and rate of runoff for channel-forming flows will be reduced in an attempt to minimize increased streambank erosion in the receiving streams and channels.

This Chapter describes measures that need to be taken to satisfy the Westfield Public Works Department (WPWD) Post-Construction Stormwater Management requirements, including Channel Protection and pollutant removal requirements.

03701.02 Abbreviations and Definitions

BMP: Best management practices can refer to structural measures (wetlands, ponds, sand filters, etc.) or non-structural measures (restrictive zoning, reduced impervious areas, etc.). BMPs are designed for the benefit of water quality and quantity. For the purposes of this chapter, BMPs refer to structural water quality BMPs, but in some circumstances, may include public education in cases where structural BMPs are not appropriate.

BMP owner: The owner of the BMP, typically the property owner. The BMP owner may also be the leasee of property in the case of long term leases of commercial or industrial zoned properties. The leasee is considered the BMP owner only if the lease specifically states that construction by the leasee must meet applicable local codes and regulations.

BOD:	Biochemical oxygen demand.
Contributing drainage area:	Contributing drainage area refers to the total drainage area to a given point, including offsite drainage.
Effective Drainage Area:	Effective drainage area refers to the drainage area from a specific site, excluding offsite drainage, where offsite drainage either does not exist or where offsite drainage bypasses the site through culverts or other means.
Floating Debris (Floatables):	Any solid waste that, due to its physical properties, will float on the surface of water. For the purpose of this manual, the term does not include naturally occurring floatables such as leaves or tree limbs.
Impervious Area:	Impervious areas are areas where the land surface has been altered to decrease the amount of rainwater infiltration. Impervious surfaces include paved roads, concrete driveways and rooftops.
Low Impact Development:	LID is a land planning and engineering design approach with a goal of replicating the pre-development hydrologic regime of urban and developing watersheds. The primary goal of LID is to mimic a site's predevelopment hydrology by reducing the impervious surface, infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.
Offline structure:	Offline structures are BMPs that treat only the water quality volume (WQv). Flows exceeding the WQv bypass the structure and re-enter the watercourse below the BMP.
Redevelopment:	Redevelopment means any construction, alteration, or improvement where structures are removed and/or replaced. Where the disturbance caused by redevelopment activities disturbs less than 0.5 acres, no water quality BMP plan shall be required. Staff has the discretion to exempt redevelopment activities disturbing up to 5% more area.
Stormwater Quality Management:	A system of vegetative, structural, and other measures that reduce or eliminate pollutants that might otherwise be carried by surface runoff.
Total P:	Total phosphorus.
Total N:	Total nitrogen.
TSS:	Total suspended solids.

Treatment train: A treatment train consists of more than one BMP in series treating stormwater runoff. Such configurations are necessary when BMPs individually cannot meet the TSS reduction goal stated in the Ordinance.

Watershed: Watershed refers to the total drainage area contributing runoff to a single point.

SECTION 03702 BASIC POLICIES AND PROCEDURES

03702.01 Policy on Post- Construction Stormwater Quality Management

The City of Westfield has determined that to prevent degradation of water quality in streams within its jurisdiction, measures must be taken to minimize the conveyance of pollutants to the receiving stream and to ensure that the channel banks of receiving streams are not subject to increased erosion as a result of development. Channel protection is typically achieved by matching the post-construction runoff volume and rate to the pre-settlement (prior to any historical land conversion by man) condition for all runoff events up to the bankfull flow. The bankfull flow in most Indiana streams correlate with 1.5 to 2-year flood event flow. However, due to difficulties in determining the pre-settlement conditions, the net control of runoff resulting from a 1-year, 24 hour storm in proposed conditions (rather than the alternative method of determining increase in 2-year, 24 hour storm over pre-settlement conditions) is established as the WPWD standard for channel protection.

The WPWD has also established a minimum standard that the measurement of the effectiveness of the control of post-construction stormwater runoff quality will be based on removal of floatables in stormwater runoff and treatment, to the maximum extent practicable, of all major pollutants of concern expected for the proposed land use and/or those identified in the Storm Water Pollution Prevention Plan for the site (including, if applicable, those pollutants found to be the cause of the receiving stream to be listed in IDEM 303(d) list) for up to the first inch of rainfall at the site. The above-noted “maximum extent practicable” criterion is subject to a minimum of 80% removal of Total Suspended Solids (TSS). These requirements are adopted as the basis of the WPWD’s stormwater quality management program for all areas of the jurisdiction.

For the purpose of these Standards, the control of post-construction stormwater runoff quality is assumed satisfactory when the appropriate number of pre-approved structural BMPs, tiered in accordance to the total site disturbed area as shown below, are designed, installed, and operated in accordance with fact sheets provided in Appendix 03702-1.

Disturbed Area	Post-Construction BMP Requirement*
0 to less than ½ acre	No BMP
At least ½ acre to less than 3 acres	At least 1 BMP
At least 3 acres	2 BMPs in series

* These BMPs are in addition to any pre-treatment that may be required for hot spots.

As noted above, a combination of at least two BMPs in series (each sized to handle water quality volume) is required for sites with a disturbed area of at least 3 acres, with the first BMP acting as a pretreatment measure to reduce pollutant concentrations within the downstream, or secondary, BMP. A dual BMP provision provides a failsafe benefit should

adverse conditions result in undue clogging or other potential BMP impairment. Only one of the required BMPs can be a proprietary Water Quality Device.

Requirements of the Ordinance and this Technical Standards Manual with regards to the channel protection and water quality protection can be satisfied through a variety of methods that can be broadly categorized under two general approaches:

1. Conventional Approach
2. Low Impact Development (LID) Approach

This chapter of the manual establishes minimum standards for the selection and design of post-construction water quality and channel protection BMPs. The information provided in this chapter establishes performance criteria for stormwater quality management and procedures to be followed when preparing a BMP plan for compliance. Post-construction BMPs must be sized to treat the channel protection volume (CPv), water quality volume (WQv), and for flow-through BMPs the water quality discharge rate (Qwq).

03702.02
Applicability and
Exemptions

In addition to the requirements of Chapter 03600, the stormwater pollution prevention plan, which is to be submitted to the WPWD as part of the stormwater management permit application, must also include post-construction stormwater quality measures. These measures are incorporated as a permanent feature into the site plan and are left in place following completion of construction activities to continuously treat stormwater runoff from the stabilized site. Any project located within the City of Westfield jurisdictional area meeting the applicability threshold in the City of Westfield Stormwater Management Ordinance is subject to the requirements of this Chapter.

The requirements under this chapter do not apply to the following activities:

- A. agricultural land disturbing activities; or
- B. timber harvesting activities; or
- C. construction activities associated with a single family residential dwelling disturbing less than 5 acres, when the dwelling is not part of a larger common plan of development or sale; or
- D. single family residential developments consisting of four or less lots; or
- E. a single-family residential strip development where the developer offers for sale or lease without land improvements and the project is not part of a larger common plan of development of sale; or
- F. individual building lots within a larger permitted project.

The requirements under this chapter do not apply to the following activities, provided other applicable State permits contain provisions requiring immediate implementation of soil erosion control measures:

- A. Landfills that have been issued a certification of closure under 329 IAC 10.
- B. Coal mining activities permitted under IC 14-34.
- C. Municipal solid waste landfills that are accepting waste pursuant to a permit issued by the Indiana Department of Environmental Management under 329 IAC 10 that contains equivalent stormwater requirements, including the expansion of landfill boundaries and construction of new cells either within or outside the original solid waste permit boundary.

It will be the responsibility of the project site owner to complete a stormwater permit application and ensure that a sufficient construction plan is completed and submitted to the WPWD in accordance with Chapter 03100. It will be the responsibility of the project site owner to ensure proper construction and installation of all stormwater BMPs (especially, the protection of the post-construction BMPs during construction phase) in compliance with all applicable ordinances and these Standards and with the approved stormwater

management permit, and to notify the WPWD with a Notice of Termination letter upon completion of the project and stabilization of the site. However, all eventual property owners of stormwater quality facilities meeting the applicability requirements must comply with the requirements of this Chapter.

03702.03
Pollutants of
Concern

There are three major sources of pollutants for a stabilized construction site:

- Deposition of atmospheric material (including wind-eroded material and dust)
- General urban pollution (thermal pollution, litter)
- Pollutants associated with specific land uses

It should be noted that some pollutants accumulate on impervious surfaces. This accumulated material is then subject to being washed into watercourses during storm events. It is for this reason that fish kills often occur during a rain event with a substantial prior rainless period. This is also the reason that the most hazardous driving conditions are realized after the initial onset of a storm event, when deposited oil has not yet washed into adjacent conveyance systems.

Post-construction pollutants of concern include:

- **Sediment** is the major pollutant of concern during active construction. Natural erosion processes are accelerated at a project site by the construction process for a number of reasons, including the loss of surface vegetation and compaction damage to the soil structure itself, resulting in reduced infiltration and increased surface runoff. After the construction is completed, other chemicals that are released to surface waters from industrial and municipal discharges and polluted runoff from urban and agricultural areas continue to accumulate to harmful levels in sediments.
- **Toxic chemicals** from illegal dumping and poor storage and handling of materials. Industrial sites pose the most highly variable source of this pollution due to the dependency of the specific process to the resulting pollution amounts and constituents. As during construction, these chemicals can pose acute (short-term) and/or chronic (long-term) risk to aquatic life, wildlife and the general public.
- **Bacteria** from illicit sanitary connections to storm sewer systems, combined sewers, leaking septic systems, wildlife and domestic animal waste. Bacteria pathogens pose a direct health risk to humans and aquatic life.
- **Nutrients** can be released from leaking septic systems or applied in the form of fertilizers. Golf courses, manicured landscapes and agricultural sources are the primary land uses associated with excess fertilization. Excessive nutrients in the local ecosystem are the source of algal blooms in ponds and lakes. These excessive nutrients also lead to acceleration of the eutrophication process, reducing the usable lifespan of these water bodies. Nitrogen and phosphorous are the primary nutrients of concern.
- **Oxygen demand** can be impacted by chemicals transported on sediment, by nutrients, and other pollutants (such as toxic chemicals). Reduced levels of oxygen impair or destroy aquatic life.
- **Oils and hydrocarbons** accumulate in streets from vehicles. They can also be associated with fueling stations and illicit dumping activities. Oils and hydrocarbons pose health risk to both humans and aquatic life.

- **Litter, including floatables**, can result in a threat to aquatic life. The aesthetic impact can also reduce the quality of recreational use.
- **Metals** can be associated with vehicular activity (including certain brake dusts), buildings, construction material storage, and industrial activities. Metals are often toxic to aquatic life and threaten human health.
- **Chlorides** (salts) are historically associated with deicing activities. Chlorides are toxic to native aquatic life (verses saltwater aquatic life). Communities should consider a combination of cinders or sand to replace or supplement their deicing activities with chlorides. In addition, chloride stockpiles should remain covered.
- **Thermal effects** can be introduced by the removal of shade provided by riparian trees, as well as impervious channel linings, such as concrete, which release stored heat to water passing over them. Other sources of elevated temperature include effluent from power plant and industrial activities. Thermal pollution can threaten aquatic habitat, including fish species and beneficial water insects. Of particular concern are salmonoid streams, due to the effect of thermal pollution on spawning for this particular species.

Direct water quality sampling is not generally required at this time under the Phase II provisions. However, water quality characteristics are strongly tied to land use. For the purpose of these standards, all proposed developments and re-developments shall be assumed to involve increased levels of floatables, TSS, TP, TN, and metals. Additional pollutants may also be expected at certain types of developments and specific sites, as identified in the Storm Water Pollution Prevention Plan for the site (including, if applicable, those pollutants found to be the cause of the receiving stream to be listed in IDEM 303(d) list).

03702.04
Conventional
Approach Procedures

The following procedures shall be followed according to the Conventional approach:

Step 1: Provide BMPs to address Channel Protection Volume

In a conventional approach, the receiving channel is protected through extended detention of the 1-year, 24 hour storm event on the entire site (disturbed and undisturbed) tributary to each outlet. Both wet and dry extended detention may be used so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% of the maximum stored volume is released within the first 12 hours. To ensure that adequate detention volume is available within the facility over the years, the facility should be designed for long-term (a minimum of 50 years) sediment accumulation. If long-term sediment accumulation cannot be adequately provided for in the pond, or if the pond is intended to provide sediment control during the construction phase of the project, forebays near inlets can be included to help manage sediment accumulation.

Since, by design, 90% of the original volume will be available within 48 hours of the start of each storm event (assumed to be about 36 hours from when the Channel Protection pool is full), the volume in the pond associated with the channel protection (CPv) may be assumed empty for the purpose of peak flow detention analysis discussed in Chapter 03300. In addition, the volume provided for channel protection would also satisfy the water quality volume (WQv) requirement provided that the facility meets the design criteria in the fact sheet and additional pre-treatment and/or wetland fringe can be provided to assure the treatment benchmarks noted in Section 03702.01 of these Standards are met.

The methodology for calculating the Channel Protection Volume (CPv) for each of site's final outlets using computer models or manual calculation is as follows:

- Computer Model: Use acceptable computer models (listed in Chapter 03200) to determine the total runoff volume for the site contributing to each site's outlet, utilizing 1-year, 24 hour rainfall depth with Soil Conservation Service (SCS) type 2 storm distribution, drainage area, and the composite CN calculated for the site, according to the Soil Conservation Service (SCS) CN loss method along with SCS unitless hydrograph methodology.
- Manual Calculation: If calculating manually, use the following formula:

$$\text{Runoff Volume (ft}^3\text{)} = Q_v \times 1/12 \times A$$

where:

A = total post-construction site area contributory to each outlet (ft²)

$Q_v = \text{Runoff Depth (in)} = (P - 0.2S)^2 / (P + 0.8S)$

P = 1-Year, 24-hr Rainfall (in)

S = 1000/CN - 10

Step 2: Provide BMPs to address Water Quality Management

When the channel protection volume is controlled with BMPs that also meet the stormwater quality performance criteria noted in Section 03702.01, often no additional calculation or BMP implementation is necessary. If the channel protection volume is not controlled through practices that meet the stormwater quality performance criteria in Section 03702.01, additional BMPs will be required.

The WPWD has designated a number of pre-approved structural BMP methods (listed in Table 03702-1 for Conventional Approach and Tables 03702-4 through 03702-6 for LID Approach) to be used alone or in combination to achieve the stormwater quality performance criteria noted in Section 03702.01 of these Standards for runoff generated from up to first inch of rainfall on the entire site (disturbed and undisturbed) tributary to each outlet. Details regarding the applicability and design of these pre-approved BMPs, including the effectiveness of these BMPs in treating pollutants of concern (including, if applicable, those pollutants found to be the cause of the receiving stream to be listed in IDEM 303(d) list), are contained within fact sheets presented in Appendix 03702-1. Additional information on recommended plant lists and recommended materials used for construction of stormwater BMPs are provided in Appendix 03702-2 and Appendix 03702-3, respectively.

Innovative BMPs, including but not limited to, BMPs not previously accepted by the WPWD must be certified by a Professional Engineer licensed in State of Indiana and approved through the WPWD. ASTM standard methods must be followed when verifying performance of new measures. New BMPs, individually or in combination, must meet the performance criteria noted in Section 03702.01 of these Standards, including the capture and removal of floatables. All innovative BMPs must have a low to medium maintenance requirement to be considered by the WPWD. Testing to establish the pollutant removal rate must be conducted by an independent testing facility, not the BMP manufacturer. The accepted design flow rate for a Water Quality Device shall be the flow value at which the claimed removal rate for TSS is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph). In rare cases where structural BMPs may not be appropriate or practical, public education may be substituted in lieu of a structural BMP. This option will be at the discretion of the WPWD.

Structural Water Quality treatment is achieved by treating the first inch of rainfall, either through detention/retention BMPs or by Flow-through BMPs. Detention/Retention BMPs impound (pond) the runoff to be treated (Water Quality Volume: WQv), while flow-through BMPs treat the runoff through some form of filtration process (Water Quality Treatment Rate: Qwq). The following methods are used as part of Conventional Approach to calculate WQv and Qwq:

Water Quality Volume (WQv)

Water Quality Detention BMPs must be designed to store the water quality volume for treatment. The water quality volume, WQv, is the storage needed to capture and treat the runoff from the first one inch of rainfall. The water quality volume is equivalent to one inch of rainfall multiplied by the volumetric runoff coefficient (Rv) multiplied by the site area.

A calculation methodology similar to that described for the channel protection volume may be utilized, except that the rainfall depth (P) will be equal to 1, instead of the 1-year, 24 hour depth.

Alternatively, a simpler methodology may be used for calculation of WQv as follows:

$$WQv = (P) (Rv) (A)/12$$

where:

WQv = water quality volume for each site's outlet (acre-feet)

P = 1 (inches)

Rv = volumetric runoff coefficient

A = total contributing area to each site's outlet in acres

The volumetric runoff coefficient is a measure of imperviousness for the contributing area, and is calculated as:

$$Rv = 0.05 + 0.009(I)$$

where:

I is the percent impervious cover

For example, a proposed commercial site will be designed to drain to three different outlets, with the following drainage areas and impervious percentages:

Subarea ID	On-site Contributing Area (acres)	Impervious Area %	Off-Site Contributing Area (acres)
A	7.5	80	0.0
B	4.3	75	0.0
C	6.0	77	0.0

Calculating the volumetric runoff coefficient for subareas A, B and C yields:

$$Rv \text{ (subarea A)} = 0.05 + 0.009(80) = 0.77$$

$$Rv \text{ (subarea B)} = 0.05 + 0.009(75) = 0.73$$

$$Rv \text{ (subarea C)} = 0.05 + 0.009(77) = 0.74$$

The water quality volumes for these three areas are then calculated as:

$$WQv \text{ (subarea A)} = (1'')(Rv)(A)/12 = 0.77(7.5)/12 = 0.48 \text{ acre-feet}$$

$$WQv \text{ (subarea B)} = 0.73(4.3)/12 = 0.26 \text{ acre-feet}$$

$$WQv \text{ (subarea C)} = 0.74(6.0)/12 = 0.37 \text{ acre-feet}$$

Note that this example assumed no offsite sources of discharge through the channel protection detention/retention BMPs. If there are significant sources of off-site runoff, the designer has the option of diverting off-site runoff around the on-site systems, or the detention BMP should be sized to treat the water quality volume for the entire contributing area, including off-site sources.

Water Quality Treatment Rate (Qwq)

Flow-through BMPs are designed to treat runoff at a peak design flow rate through the system. Examples of flow through BMPs include catch basin inserts, sand filters, and grassed channels. Another flow through BMP which is gaining popularity is a hydrodynamic separator or other similar type of device discussed in the Water Quality Devices Fact Sheet (Appendix 03702-1). Hydrodynamic separators are proprietary, and usually include an oil-water separation component. Hydrodynamic separators (i.e. Gravity or Manufactured Stormwater Quality Units) located on the City of Indianapolis Stormwater Quality Unit Selection Guide will be accepted when installed off-line. New units not on this list will be accepted on a case by case basis with 3rd party testing data and specifications required as well as a written narrative explaining the water quality benefits of the BMP. Runoff rate calculations for each site should be completed according to the instructions in these Standards for the one inch rainfall event. Once a runoff rate has been determined, a unit with a corresponding acceptable treatment rate can be selected from the Indianapolis selection guide. For treatment device Operation and Maintenance manuals, applicants shall at a minimum follow the standard treatment unit checklists and notes as provided in the selection guide unless these conflict with other City of Westfield Public Works Department Standards and Specifications. In the event that the Indianapolis selection guide no longer exists, applicants shall provide independent, third party documentation to prove that a treatment unit meets TSS removal to the highest extent practicable for a particle size of 50-125 microns and/or the OK-110 particle size distribution. If the City of Indianapolis selection guide is not used and for innovative BMPs, the accepted design flow rate for a Water Quality Device shall be the flow value at which the claimed removal rate for TSS is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph).

The following procedure should be used to estimate peak discharges for flow through BMPs (adopted from Maryland, 2000). It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt, 1994) and utilizes the NRCS, TR-55 Method.

Using the WQv methodology, a corresponding Curve Number (CNwq) is computed utilizing the following equation:

$$CNwq = \left[\frac{1000}{10 + 5P + 10Qa - 10\sqrt{Qa^2 + 1.25QaP}} \right]$$

where:

CNwq = curve number for water quality storm event

P = 1" (rainfall for water quality storm event)

Qa = runoff volume, in inches = 1"×Rv = Rv (inches)

Rv=volumetric runoff coefficient (see previous section)

Due to the complexity of the above equation, the water quality curve number is represented as a function of percent imperviousness in Exhibit 03701-1.

The water quality curve number, CNwq, is then used in conjunction with the standard calculated time-of-concentration, tc, and drainage area as the basis input for TR-55 calculations. Using the SCS Type II distribution for 1 inch of rainfall in 24 hours, the water quality treatment rate, Qwq, can then be calculated.

Note that a single BMP measure may not be adequate to achieve the water quality requirements (as noted above) for a project. It is for this reason that a "treatment train", a number of BMPs in series, is often required for a project. The pollutant removal efficiency of a number of BMPs in series may be determined from the following formula:

$$E_{\text{series}} = 1 - (1-E_1)(1-E_2)(1-E_3)\dots$$

where:

E_{series} = Removal Efficiency of the BMP series combined (in decimal form)

E_1, E_2, E_3, \dots = Removal Efficiency of Units 1, 2, 3, ..., respectively (in decimal form)

03702.05
LID Stormwater
Management
Approach

Low impact development (LID) stormwater management design approaches are fundamentally different from conventional design approaches and challenge traditional thinking regarding development standards, watershed protection, and public participation. LID combines fundamental hydrologic concepts with many of today's common stormwater strategies, practices and techniques to reshape development patterns in a way that maintains natural watershed hydrologic functions. When a county or community has a stormwater user fee system based on imperviousness, the utilization of LID concepts also often results in a smaller stormwater user fee for non-residential lots. The five principles of LID are:

- a) Conservation of existing natural and topographic features;
- b) Minimization of land clearing and impervious surfaces;
- c) Maintain or lengthen the pre-developed time of concentration;
- d) Installation of integrated structural best management practices; and
- e) Use of pollution prevention measures and practices.

Several methods for achieving the above requirements and principals are outlined below. In addition to methods described in this Standards Manual, several readily available references provide details on incorporating LID practices into site development. One of the most recent, comprehensive resources for incorporating LID practices into site development design is "Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers" available online at www.semcog.org/LowImpactDevelopment.aspx. The noted resource was used extensively for the development of LID section in this Standards Manual.

The following steps shall be followed for the LID approach:

Step 1: Minimize Disturbed Areas and Protect Sensitive Areas

- Map sensitive areas such as waterbodies, floodplains, and natural flow paths. Identify hydrologic soil types on the maps. Show elevations and identify critical slopes of 15 percent to 25 percent and above 25 percent. Show areas of known contamination. Also show existing structures and infrastructure.
- Determine the total area of impervious surface existing prior to development.
- Note the seasonal high groundwater level.
- Designate sensitive areas that are proposed to be protected as part of the proposed layout.
- Lay out the proposed development, minimizing disturbance and avoiding the sensitive areas.
- Utilize the non-structural BMPs listed in Table 03702-2 to properly protect sensitive areas so they maintain their pre-development state and runoff characteristics. Fact sheets for non-structural BMPs are provided in Appendix 03702-1.
- As shown in Table 03702-2, when using the LID Approach, any area that is set aside and protected as described in those BMPs may be subtracted from site development area for purposes of determining Channel Protection Volume calculations and water quality volume/rate calculations.
- In addition, for determining the 10-year and 100-year runoff and peak discharges, the CN associated with the original, pre-development soil groups

(instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) may be used for these areas (see Table 03702-8).

- The runoff reduction recognition only works with designs based on the Curve Number or CN method of analysis utilizing non-composite CN determination methods.

Step 2: Restore Disturbed Areas

- For the LID Approach, runoff reduction recognitions are used in the design process to emphasize the use of BMPs that, when applied, restore/alter the disturbed area in a way that reduces the volume of runoff from that area.
- Runoff reduction recognition is provided for the five BMPs listed in Table 03702-3 because they enhance the response of a piece of land to a storm event rather than treat the runoff that is generated. These BMPs are encouraged because they are relatively easy to implement over structural controls, require little if any maintenance, and the land they are applied to remains open to other uses.
- Runoff reduction recognition is applied by reducing the default CN value so that the amount of runoff generated from an event is reduced.
- The runoff reduction recognition only works with designs based on the Curve Number or CN method of analysis utilizing non-composite CN determination methods.
- Fact sheets for these BMPs are provided in Appendix 03702-1.

Step 3: Minimize Imperviousness

- The BMPs listed in Table 03702-4 are designed to reduce the volume of runoff from hard surfaces such as roads, sidewalks, parking areas, roofs, etc. For the LID Approach, runoff reduction recognition is used to encourage these practices and recognize their runoff reduction impacts. Fact Sheets for these BMPs are provided in Appendix 03702-1.
- Although imperviousness reduction BMPs are encouraged throughout any new development or re-development, the runoff reduction recognitions may only be considered where the following conditions are met:
 - The BMP must be in the common areas and covered by an easement or other agreement that assigns responsibility for its maintenance.
 - The BMP must be covered by a maintenance plan and agreement with assurances for the long-term availability of maintenance funds (such as funds held in a permanent escrow account) provided to the WPWD in a form acceptable to the WPWD.

Step 4: Calculate the amount of volume control needed for channel protection

- Determine the 1-year, 24 hour rainfall from Table 03201-3 in Chapter 03200.
- Delineate subbasins in a manner that, at a minimum and to the extent possible, the pervious and impervious surfaces are in different subbasins.
- Determine the disturbed drainage area for each subbasin by subtracting the protected area determined in Step 1 from total contributing drainage area.
- Assign CN to each cover type and land use, assigning “credited CN” for areas treated in Steps 2 and 3 instead of normal post-development CN that is determined based on the proposed land use and the next less infiltrating underlying soil group, when applicable. Published pre-determined weighted CN values shall not be utilized for LID Approach. This applies regardless of whether manual methods or computer modeling techniques are used.
- Determine the total post-development 1-year, 24 hour runoff volume for the entire site’s disturbed areas through the use of acceptable computer models

or manually as specified below. This is the net Channel Protection volume needing to be permanently removed by appropriate structural BMPs.

- Computer Model: Use acceptable computer models (listed in Chapter 03200) to determine the total runoff volume for the site contributing to each site's final outlet, utilizing 1-year, 24 hour rainfall depth with Soil Conservation Service (SCS) type 2 storm distribution, drainage area, and CN determined above, according to the Soil Conservation Service (SCS) CN loss method along with SCS unitless hydrograph methodology.
- Manual Calculation: If calculating manually, use the following formula:

Runoff Volume (ft³) for each post-construction cover type contributing to each outlet = $Q_v \times 1/12 \times A$

where:

A = disturbed area of the particular cover type (ft²)

$Q_v = \text{Runoff Depth (in)} = (P - 0.2S)^2 / (P + 0.8S)$

P = 1-Year, 24-hr Rainfall (in)

S = $1000 / \text{CN} - 10$

- Sum the individual volumes to obtain the total post-development runoff volume for area to be managed.

Step 5: Provide Distributed Volume Reduction/Infiltration Practices

- Table 03702-5 includes a list of the structural BMPs from potential BMPs that provide volume removal. Select and design structural BMPs that provide volume control to meet, when combined, the total net channel protection volume determined in Step 4. Fact sheets for these and other relevant post-construction structural BMPs are provided in Appendix 03702-1.
- The volume reduction BMPs may not be successfully implemented in every situation. See "Applicability and Limitation" discussions in each fact sheet. In order to qualify for volume reduction recognition, the BMPs must meet all the following:
 - Be in the common areas and covered by an easement or other agreement that assigns responsibility for its maintenance.
 - Be covered by a maintenance plan and agreement with assurances for the long-term availability of maintenance funds (such as funds held in a permanent escrow account) provided to the WPWD in a form acceptable to the WPWD.
 - Be constructed on undisturbed A or well-drained B soils (B/D soils do not qualify) or amended soil with underdrains, as needed. If underdrains are used, the bottom elevations of the underdrains should be above the seasonal high water table. Soil infiltration testing protocol, provided in Appendix 03702-4, must be followed to determine if infiltration BMPs are suitable at a site and to obtain the required data (such as soil conditions and depth of seasonal high water table) for infiltration design.
 - Be constructed in an area where the depth of seasonal high water table and any bedrock is more than a minimum of 2 feet (4 is desirable) from ground elevation.
 - Be constructed in a manner that any infiltration practices are adequately separated from basement foundations (50 feet up gradient, 10 feet down gradient), on-site septic systems/drainfields (100 feet), wells (50 feet), and other building elements that could be affected by infiltration systems.
 - Be constructed outside of any 1-year (Zone 1) or 5-year (Zone 2) time of travel areas to public water supply wells, as defined by a modeled wellfield delineation performed in compliance with 327

- IAC 8-4.1. When such delineation is not available, said practice must be at least 3,000 feet from the nearest public water supply well (unless applicant can demonstrate that the proposed practice will have no impacts on the water quality of the water supply well).
 - o Final construction should be completed after the contributing drainage area has been stabilized.
 - o Must contain erosion-protection features at the inflow to prevent scouring
 - o Must contain a maintenance area near the inlet to collect large debris. Examples include small concrete aprons, catch basin inserts, or similar durable maintenance point.
- When the LID Approach is being pursued in all other aspects of the design but site limitations would not allow permanent volume reduction practices, channel protection volume should, at a minimum and as site limitations would allow, be accommodated through distributed storage solutions noted in Table 03702-5 that also include underdrains as described in the appropriate Fact Sheets so that at a minimum they can act as both extended detention and filtration practices.
- **Calculation Methods for Recognizing Impacts of Distributed Storage on Overall Site's Peak Flow Detention Requirements:** When all the stated conditions above are met for volume-reduction distributed storage practices noted in Table 03702-5, total volume provided for channel protection within distributed storage units (not to exceed the required channel protection volume calculated in Step 4) may be credited towards the site's detention requirements for peak (100-year) flow control (see Table 03702-8). Several methods are available to account for the noted runoff reduction recognition. A few common methods are listed below (other methods not noted below may also be used as appropriate):
 - o Method 1: Assume that the provided Channel Protection Volume in the distributed storage units (not to exceed the required channel protection volume calculated in Step 4) will be stored below the detention pond's normal pool (below the lowest outlet). To simulate this condition, all the volumes in the elevation-storage table are increased by the provided Channel Protection Volume, an additional table entry is made as the first row with an artificial lower elevation and with zero for storage, and the reservoir's starting elevation is set at the noted artificial elevation.
 - o Method 2: Utilize the "Divert" option of the hydrologic model used to compute the inflow to the pond to simulate the diversion (abstraction) of the provided Channel Protection Volume (not to exceed the required channel protection volume calculated in Step 5) from the detention pond inflow before the remaining flood hydrograph is routed through the detention system. To accomplish this, the model should have capability to simulate diversion with a volume cap option.
 - o Method 3: Explicitly model the distributed storage features as a network of storage and conveyance units through the use of computer programs that can correctly model interconnected storage.

Step 6: Provide Additional (as-needed) Extended Detention Practices

- When the LID Approach is being pursued in all other aspects of the design but site limitations would not allow adequate distributed volume reduction practices noted in Step 5 (with or without underdrain), then a constructed wetland or a wet-bottom extended detention facility along with incorporation of an appropriate wetland fringe should be utilized as listed in Table 03702-6. If designed properly, such a facility can be incorporated into a multi-purpose facility to control channel protection volume, water quality volume,

and 100-year peak flow rate. Note that since by design conditions of a wet-bottom extended detention facility, 90% of the original volume will be available within 48 hours of each storm event (i.e., a maximum of 36 hours from when the channel protection pool is full), the volume in the pond associated with the channel protection may be assumed empty for the purpose of peak flow detention analysis discussed in Chapter 03300 of these Standards (see Table 03702-8).

Step 7: Determine Water Quality Volume and Provide, As-needed, Additional Water Quality BMPs

- The expected treatment of many BMPs applied to LID designs is based on removing solids. Many pollutants are attached to solids or are removed by similar treatment mechanisms. Therefore, removing solids can act as a surrogate for the expected removal of other particulate pollutants. Often multiple BMPs will be necessary to remove successively smaller particle sizes to achieve the highest level of treatment.
- When the channel protection volume is controlled with BMPs that also meet the stormwater quality performance criteria in Section 03702.01, often no additional calculation or BMP implementation is necessary. If the channel protection volume is not controlled through practices that also meet the stormwater quality performance criteria in Section 03702.01, calculate the water quality volume that provides for the treatment of the first inch of rainfall on the site's disturbed areas as discussed below.
- The methodology to determine the design water quality volume or rate for the LID approach is the same as that described for the Channel Protection Volume calculation described in Step 4, except that the rainfall depth for the Water Quality will be 1 inch instead of the 1-year, 24 hour rainfall depth used for calculating the Channel Protection Volume. A few considerations specific to Water Quality Volume/Rate calculations are as follows:
 - Time of Concentration in the case of LID design is the time it takes a drop of water to move from the furthest point in the disturbed area to its discharge from the disturbed area.
 - Computer Model: If using acceptable computer models, perform the same procedure as that performed for calculating CPv in Step 4, but for 1 inch of rainfall depth.
 - Manual Calculation: If calculating manually, use the following formula:

$$\text{Runoff Volume (ft}^3\text{) for each cover type} = Q_v \times 1/12 \times A$$

where:

$$A = \text{disturbed area of the particular cover type (ft}^2\text{)}$$

$$Q_v = \text{Runoff Depth (in)} = (P - 0.2S)^2 / (P + 0.8S)$$

$$P = 1 \text{ inch}$$

$$S = 1000 / \text{CN} - 10$$

$$\text{Peak Runoff Rate (ft}^3\text{/sec)} = q_u \times A \times Q_v \times 1/43,560$$

where:

$$A = \text{disturbed area of the particular cover type (ft}^2\text{)}$$

$$Q_v = \text{Runoff Depth (in) calculated in previous step}$$

$$q_u = \text{Unit Peak Discharge (cfs/mi}^2\text{/in), determined from TR-55 Exhibit 4-II}$$

- Sum the individual volumes and peak runoff rates to obtain the total design post-development water quality runoff volume and rate.

- Determine the total post-development water quality runoff volume and rate for the entire site's disturbed areas. These are the design post-development water quality runoff volume and rate needing to be treated.
- Select BMPs from the list provided in Table 03702-1 that will meet the performance criteria noted in Section 03702.01 of this Chapter. Often, multiple types of BMPs used in series will be required to provide adequate treatment. Design the BMPs in conjunction with any detention control that is needed for peak rate control of larger floods (100-year), if possible.

Step 8: Complete the LID Approach Utilization Summary Form

- As the final step of the LID Approach, a summary of non-structural and structural BMPs utilized, as part of the LID Approach, in the site design of a particular development site is provided in Table 03702-7 and submitted as part of the permit request package.
- The presence of Table 03702-7 in the submittal package and the information contained in the form would alert the plan reviewer that the LID Approach is being used to meet the post-construction stormwater quality requirements of the site and that the overall site design as well as peak discharge and detention calculations should be reviewed with the impacts of LID Approach in mind.

Summary of Runoff Reduction Recognitions for Water Quality Volume, Channel Protection, and Peak Flow Control Detention Volume for LID approach

As discussed throughout this Section, to encourage LID approach for stormwater management, runoff reduction recognitions towards all three major stormwater management requirements, i.e., Water Quality, Channel Protection, and Peak Runoff Detention, are associated with various BMPs as noted through the above 8-step process. These runoff reduction recognitions are summarized in Table 03702-8.

03702.06
Special Provisions
for "Hot Spot" Land
Uses

For all those projects involving land uses considered to be high pollutant producers or "hot spots" (see Table 03702-9 e.g., vehicle service and maintenance facilities, vehicle salvage yards and recycling facilities, vehicle and equipment cleaning facilities, fleet storage areas for buses, trucks, etc., industrial/commercial or any hazardous waste storage areas or areas that generate such wastes, industrial sites, restaurants and convenience stores, any activity involving chemical mixing or loading/unloading, outdoor liquid container storage, public works storage areas, commercial container nurseries, and some high traffic retail uses characterized by frequent vehicle turnover), additional water quality requirements may be imposed by the WPWD in addition to those included in water quality criteria in order to remove potential pollutant loadings from entering either groundwater or surface water systems. These pre-treatment requirements are included in Table 03702-9 and Table 03702-10.

03702.07
Construction
Sequencing
Considerations

BMPs noted in this chapter refer to post-construction BMPs, which continue to treat stormwater after construction has been completed and the site has been stabilized. Installing certain BMPs, such as bioretention areas and sand filters, prior to stabilization can cause failure of the measure due to clogging from sediment. If such BMPs are installed prior to site stabilization, they should be protected by traditional erosion control measures.

In those instances, the construction sequence must require that the pond is cleaned out with pertinent elevations and storage and treatment capacities reestablished as noted in the accepted stormwater management plan.

03702.08
Easement
Requirements

All stormwater quality management systems, including detention or retention basins, filter strips, pocket wetlands, in-line filters, infiltration systems, conveyance systems, structures and appurtenances located outside of the right-of-way shall be designated as common areas and incorporated into permanent, exclusive easements. For developments which fall under the jurisdictional authority of Hamilton County Drainage Board, the developer shall petition to establish the noted system as a portion of regulated drainage system pursuant to the provisions of I.C.-36-9-27, and the drainage plan shall not be accepted until such petition is submitted in a form accepted by Hamilton County Drainage Board. For the purposes of access, monitoring, inspection, and general maintenance activities, adequate easement width, as detailed in Table 03701-1, beyond the actual footprint of the stormwater quality management facility as well as a 20-foot wide access easement from a public right-of-way to each BMP shall be provided. The easement requirements noted in Table 03701-1 and this section may be changed by WPWD as deemed necessary for specific cases. In addition, protected/restored areas for which recognition is sought (Steps 1 and 2 of LID Approach) must be left undisturbed in perpetuity and covered by a conservation easement or a similar instrument to ensure non-disturbance in perpetuity.

03702.09
Inspection,
Maintenance, Record
Keeping, and
Reporting

After the approval of the stormwater management permit by WPWD and the commencement of construction activities, the WPWD has the authority to conduct inspections of the work being done to ensure full compliance with the provisions of this chapter, this document, and the terms and conditions of the approved permit.

Stormwater quality facilities shall be maintained in good condition, in accordance with the Operation and Maintenance procedures and schedules listed in this document, and/or the terms and conditions of the approved stormwater permit, and shall not be subsequently altered, revised, or replaced except in accordance with the approved stormwater permit, or in accordance with approved amendments or revisions in the permit. Checklists provided in Appendix 03702-5 or equivalent forms must be completed and maintained by the owner. In addition, a maintenance agreement in the format provided in Appendix 03702-6 shall be executed for all proposed stormwater management BMPs and submitted as part of the project permit package.

The WPWD also has the authority to perform long-term, post-construction inspection of all public or privately owned stormwater quality facilities. The inspections will follow the Operation and Maintenance procedures included in this document and/or permit application for each specific BMP. The inspection will cover physical conditions, available water quality storage capacity and the operational condition of key facility elements. Noted deficiencies and recommended corrective action will be included in an inspection report.

BMP ^A	Typical % Removal Efficiency ^B	Maintenance Easement Requirements
	TSS	
Bioretention	90 ^C	25 feet wide along the perimeter
Constructed Wetland	67 ^C	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Underground Detention	70	20 feet wide strip from access easement to tank's access shaft & 30 feet wide along centerline of inlet and outlet
Extended Detention/Dry Pond	72	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Infiltration Basin	87	25 feet wide along the perimeter
Infiltration Trench	90 ^C	25 feet wide along the perimeter
Constructed (Sand) Filter	70 ^C	25 feet wide along the perimeter
Water Quality Device	NA ^D	20 feet wide strip from access easement to chamber's access shaft
Vegetated Filter Strip	78 ^C	25 feet wide along the length on the pavement side
Vegetated Swale	81 ^C	25 feet wide along the top of bank on one side
Wet Ponds/Retention Basin	80	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet

Notes:

- A. Detailed specifications for these BMPs are provided in the fact sheets contained in Appendix 03702-1.
- B. Removal rates shown are based on typical results. Unless otherwise shown, data extracted by CBBEL from various data sources. These rates are also dependent on proper installation and maintenance. The ultimate responsibility for determining whether additional measures must be taken to meet the Ordinance requirements for site-specific conditions rests with the applicant.
- C. IDEM Stormwater Quality Manual, 2007.
- D. The removal rate for this category varies widely between various models and manufacturers. Independent testing must be provided, rather than the manufacturer's testing data. In lieu of Independent testing data, the latest pre-approved proprietary BMPs list from the City of Indianapolis. These BMPs must be configured as offline units. The accepted design flow rate for a Water Quality Device shall be the flow value at which 80% TSS removal rate is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph).

TABLE 03702-1: Pre-approved Post-Construction BMPs for Conventional Approach

BMP ^A	Runoff Reduction Recognition ^B
Protect Sensitive Areas	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Protect Riparian Buffers	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Minimize Total Disturbed Area	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Reduce Impervious Surfaces	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Protect Natural Flow Pathways	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Cluster-Type Development	Area (undisturbed acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.

Notes:

- A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.
- B. If the LID track is pursued, reduced CNs (associated with pre-developed underlying soil types instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) for areas protected by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8**.

TABLE 03702-2:Pre-approved BMPs with Treatment Area Reduction Recognition for LID Approach

BMP ^A	Runoff Reduction Recognition ^B
Minimize Soil Compaction	Area (acres complying with the requirements of this BMP) can be assigned a CN based on the Pre-developed soil group conditions instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group.
Protection of Existing Trees within disturbed areas (part of Protect Sensitive Areas)	Trees protected under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 800 square feet per tree instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the tree area.
Soil Amendment and Restoration	Area (acres complying with the requirements of this BMP) can be assigned a CN based on the Pre-developed soil group conditions instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group.
Native Revegetation	Proposed trees and shrubs to be planted under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 200 square feet per tree and 25 square feet per shrub instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the existing land use area.
Riparian Buffer Restoration	Proposed trees and shrubs to be planted under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 200 square feet per tree and 25 square feet per shrub instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the existing land use area.

Notes:

- A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.
- B. If the LID track is pursued, reduced CNs (associated with pre-developed underlying soil types instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) for areas covered by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8**.

Table 03702-3: Pre-approved BMPs with CN Reduction Recognition for Restoring Disturbed Areas as Part of LID Approach

BMP ^A	Runoff Reduction Recognition ^B
Porous Pavement	<p>Area covered by Porous Pavement with a minimum of 8 inch washed aggregate base may be assigned a weighted CN value of 87 (instead of CN of 98 normally used for impervious surfaces) for the purpose of Channel Protection Volume calculations. Use a weighted CN of 74 for the purpose of Water Quality Volume calculations, if needed.</p> <p>Note: If this BMP is specifically designed to provide permanent volume reduction through infiltration or through providing detention storage within the aggregate void, the volume reduction recognition discussed in Step 5 should be pursued instead of the CN reduction credit, assuming CN of 98.</p>
Vegetated Roof	<p>Vegetated roofs are designed to reduce runoff volumes. However, the volume reduction is highly dependent on the media and planting used, with the calculation methods very complex at times. In lieu of calculating the volume reduction benefits, the roof area with vegetated roof with a minimum media depth of 4 inches and a void ratio of 0.3 (as described in the fact sheet) may be assigned a weighted CN of 87 (instead of CN of 98 normally used for impervious surfaces) for the purpose of Channel Protection Volume calculations. Use a weighted CN of 74 for the purpose of Water Quality Volume calculations, if needed.</p>

Notes:

- A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.
- B. If the LID track is pursued, reduced CNs for areas covered by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8** for weighted CN values used for such larger events.

Table 03702-4: Pre-approved BMPs with CN Reduction Recognition for Reducing Imperviousness as Part of LID Approach

BMP ^A	Channel Protection Volume Reduction Recognition ^B
Infiltration Practices (Infiltration Basin, Subsurface Infiltration Bed, Infiltration Trench, and Dry Well)	Volume reduction is achieved by surface storage volume (if included in the design), subsurface volume (if included in the design), and infiltration volume as described in the fact sheet. If an underdrain has to be used due to soil conditions, no credit is granted for the “infiltration volume” portion.
Bioretention	Volume reduction is achieved by surface storage volume, soil storage volume, and infiltration bed volume as described in the fact sheet.
Vegetated Swale	Volume reduction is achieved by surface storage volume (if included in the design through inclusion of check dams) and active infiltration volume during the storm (when infiltration is expressly designed for as a purpose) as described in the fact sheet.

Notes:

- A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.
- B. If the LID track is pursued, the volume reduction provided by these BMPs may be recognized/credited towards determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8** for extent of runoff reduction recognition allowed for such larger events.

Table 03702-5: Pre-approved Structural BMPs with Permanent Volume Reduction Recognition for Channel Protection as Part of LID Approach

BMP ^A	Runoff Reduction Recognition ^B
Constructed Wetland	The volume of the supplementary extended detention, in lieu of permanent volume reduction, is credited towards meeting Channel Protection Volume requirements so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% from the maximum stored volume is released within the first 12 hours.
Extended Detention Wet/Dry Pond	The volume of the supplementary extended detention, in lieu of permanent volume reduction, is credited towards meeting Channel Protection Volume requirements so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% of the maximum stored volume is released within the first 12 hours.

Notes:

- A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.
- B. If the LID track is pursued, the volume reduction provided by these BMPs may be recognized/credited towards determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8** for extent of runoff reduction recognition allowed for such larger events.

Table 03702-6:Pre-approved BMPs with Additional, As-needed Extended Detention Runoff Reduction Recognitions for Channel Protection as Part of LID Approach

This checklist is a tool to allow both the regulatory agency and the Developer to reference various LID measures implemented within the development in order to meet the development's Post Construction Stormwater Management requirements.					
Project Name:		Engineer:		Developer:	
Total Site Area: _____ sf Proposed Earth Disturbance Area: _____ sf Existing Impervious Area: _____ sf					
LID Approach Step	Potential BMPs	√	Total Surface Area (sf) of LID Measure/BMP	Plan Pg # of LID Measure	Pg # of Calculations for LID Measure
1. Minimize Disturbed Areas	Protect Sensitive Areas				
	Protect Riparian Buffers				
	Protect Natural Flow Pathways				
	Minimize Total Disturbed Area				
	Reduce Impervious Surfaces				
	Cluster-Type Development				
2. Restore Disturbed Areas	Minimize Soil Compaction				
	Protect Trees in Disturbed Areas				
	Soil Amendment and/or Restoration				
	Native Revegetation				
	Riparian Buffer Restoration				
3. Minimize Imperviousness	Porous Pavement				
	Vegetated Roof				
4. Determine Volume Control Needed for Channel Protection	N/A (calculation step only)		N/A		
5. Provide Distributed Retention/Infiltration Practices	Infiltration Practices*				
	Bio-retention				
	Vegetated Swale				
6. Additional (as-needed) Extended Detention Practices	Constructed Wetland		N/A		
	Extended Detention Wet/Dry Pond		N/A		
7. Additional (as-needed) Water Quality BMPs	Pre-approved BMPs noted in Table 8-1 for conventional method		N/A		
Additional Flood Peak Control (2yr-100yr)	Detention Pond (wet/dry/underground)		N/A		
Total Surface Area of LID Measures			_____ sf		
Proposed Final Impervious Surface Area			_____ sf		
Percent of Total Site Area Covered by LID			_____ %		
Note: Not all LID measures are necessary or appropriate for every site. It is imperative that proper site assessments and due diligence is completed by the Developer and/or Engineer prior to design.					

*: Infiltration Practices include: Infiltration Basins, Subsurface Infiltration Beds or Trenches, and Dry Wells

Table 03702-7: LID Approach Summary Checklist

LID BMP GROUP	DESCRIPTION	POTENTIAL BMPS	RUNOFF REDUCTION RECOGNITION FOR POST-CONSTRUCTION WATER QUALITY CALCULATIONS		RUNOFF REDUCTION RECOGNITION FOR WATER QUANTITY (DETENTION AND STORM DRAIN) CALCULATIONS
			WATER QUALITY VOLUME	CHANNEL PROTECTION VOLUME	
1	Minimize Disturbed Areas	<ul style="list-style-type: none"> Protect Sensitive Areas Protect Riparian Buffers Minimize Total Disturbed Area Protect Natural Flow Pathways Reduce Impervious Surfaces Cluster-Type Development 	Full recognition through allowing to use "disturbed surface area" only for all calculations	Full recognition through allowing to use "disturbed surface area" only for all calculations	Full recognition through allowing CN for the undisturbed, protected area to be calculated based on pre-developed underlying soil types
2	Restore Disturbed Areas	<ul style="list-style-type: none"> Minimize Soil Compaction Protection of Existing Trees within disturbed areas (part of Minimize Total Disturbed Area) Soil Amendment and Restoration Native Revegetation Riparian Buffer Restoration 	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types
3	Minimize Imperviousness	<ul style="list-style-type: none"> Porous Pavement 	Full recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (74 instead of 98) AND full recognition of the stored volume (if provided for in the design) and WQ treatment, if designed as a true infiltration practice (no underdrain/ or extended 24-48 hrs release)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (87 instead of 98) AND full recognition of the stored volume (if provided for in the design), if designed as a true infiltration practice (no underdrain/ or extended 24-48 hrs release)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on pre-set values (89 for 10-year and 90 for 100-year calculations instead of using 98) and full recognition of the stored volume (if provided for in the design), on a case by case basis, treated as an underground detention
		<ul style="list-style-type: none"> Vegetated Roof 	Full recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (74 instead of 98) AND full recognition of the stored volume (if provided for in the design) and/or WQ treatment if designed for	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (87 instead of 98)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value 89 for 10-year and 90 for 100-year calculations instead of using 98)
4	Provide Distributed Infiltration Practices (or Filtration Practices, if underdrains have to be provided) in Common Areas	<ul style="list-style-type: none"> Infiltration Practices (Infiltration Basin, Subsurface Infiltration Bed, Infiltration Trench, and Dry Well) Bioretention Vegetated Swale 	Full recognition of perviousness through allowing CN for the application area to be calculated based on cover type and underlying soil AND full recognition of the retained volume (if provided for in the design) and/or WQ treatment if designed for	Full recognition of retained volume if designed as true infiltration practice (on appropriate soil and no underdrain/ or extended 24-48 hrs release)	Limited recognition of retained volume (up to the Channel Protection Volume) if designed as true infiltration practice (on appropriate soil and no underdrain/ or extended 24-48 hrs release)
5	Provide, as-needed, Extended Detention Practices in Common Areas	<ul style="list-style-type: none"> Constructed Wetland Extended Detention Wet/Dry Pond 	full recognition of the stored volume (with extended 24-48 hrs release) and/or WQ treatment if designed for	Full Recognition of stored volume (with extended 24-48 hrs release)	Full Recognition of stored volume (with extended 24-48 hrs release)
6	Provide, As needed, Additional Water Quality BMPs	<ul style="list-style-type: none"> Pre-approved BMPs noted in Table 702-1 for conventional method 	Full recognition of WQ treatment	N/A	N/A

Table 03702-8: Summary of Runoff Reduction Recognitions for Pre-Approved BMPS Used in the LID Approach

Stormwater Hot Spots	Minimum Pre-Treatment Options
Vehicle Maintenance and Repair Facilities	A, E, F, G
Vehicle Fueling Stations	A, D, G
Drive-through Restaurants, Pharmacies, Convenience Stores	B, C, D, I, K
Outdoor Chemical Mixing or Handling	G, H
Outdoor Storage of Liquids	G
Commercial Nursery Operations	I, J, L
Other Uses or Activities Designated by Appropriate Authority	As Required

Table 03702-9: Pre-Treatment options for Stormwater Hot Spots

Minimum Pre-Treatment Options	
A	Oil/Water Separators / Hydrodynamic Separators
B	Sediment Traps/Catch Basin Sumps
C	Trash/Debris Collectors in Catch Basins
D	Water Quality Inserts for Inlets
E	Use of Drip Pans and/or Dry Sweep Material under Vehicles/Equipment
F	Use of Absorbent Devices to Reduce Liquid Releases
G	Spill Prevention and Response Program
H	Diversion of Stormwater away from Potential Contamination Areas
I	Vegetated Swales/Filter Strips
J	Constructed Wetlands
K	Stormwater Filters (Sand, Peat, Compost, etc.)
L	Stormwater Collection and Reuse (especially for irrigation)
M	BMPs that are a part of a Stormwater Pollution Prevention Plan (SWPPP) under a NPDES Permit

Table 03702-10: Minimum Pre-Treatment Options

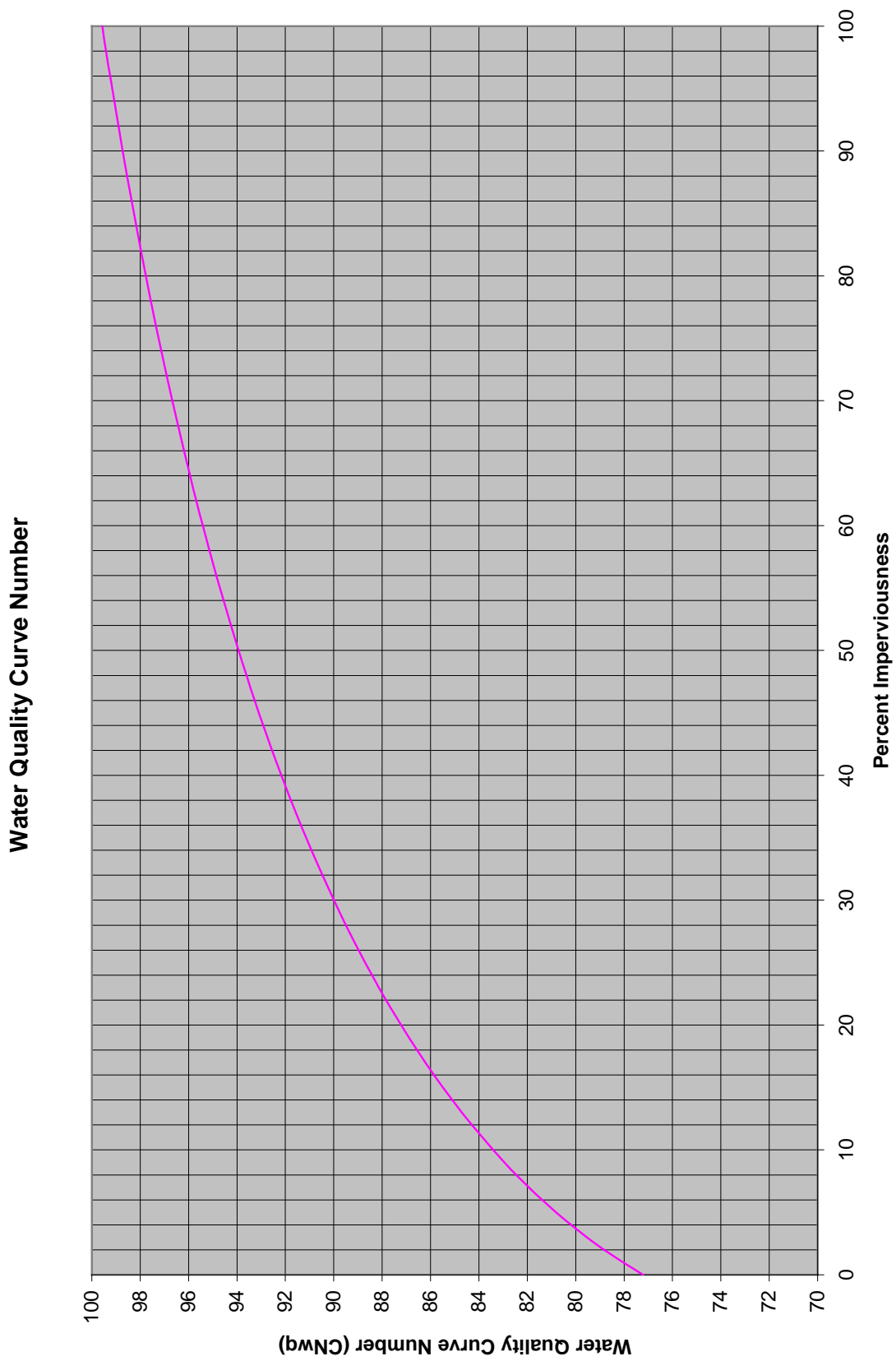


Exhibit 03702-1: Curve Number Calculation for Water Quality Storm Event

CITY OF WESTFIELD

Stormwater Management Technical Standards Manual

SECTION 03800

CITY OF WESTFIELD

STORMWATER MANAGEMENT TECHNICAL STANDARD

DETAILS

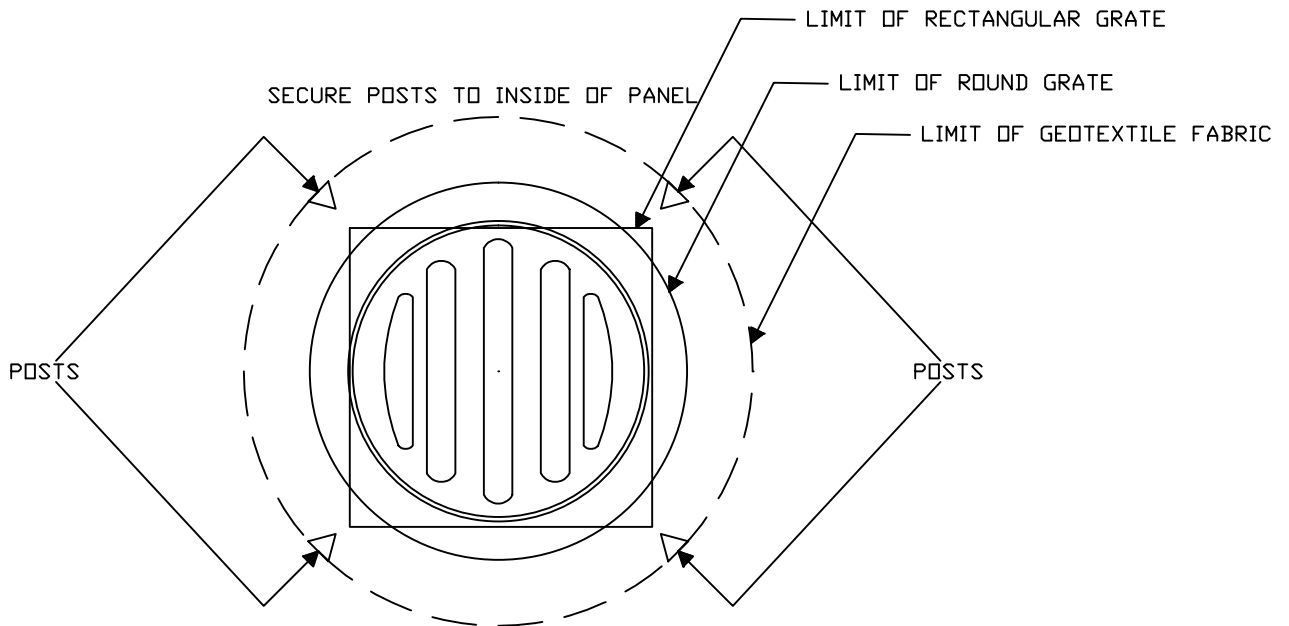
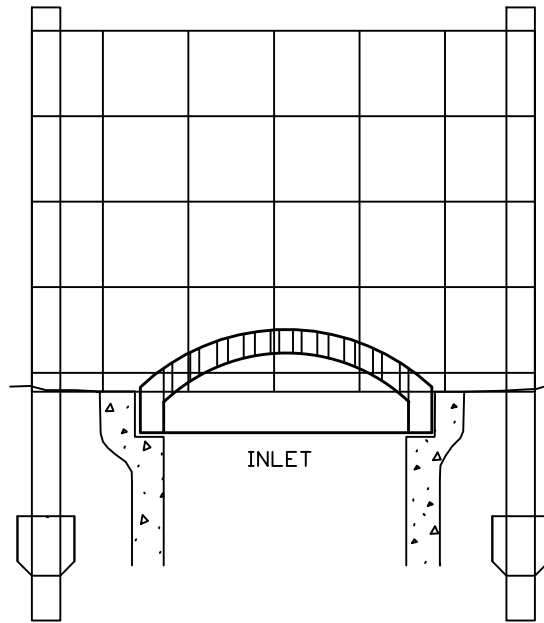
LIST OF FIGURES

<u>FIGURE</u>	<u>DESCRIPTION</u>
EC-01	Temporary Ditch Inlet Protection
EC-02	Erosion Control Mat – Slope Detail
EC-03	Erosion Control Mat – Staple Guide
EC-04	Silt Fence Detail
EC-05	Concrete Washout Detail
EC-06	Inlet Protection
EC-07	Rock Check Dam – Riprap
EC-08	Gabion Anchor Detail
EC-09	Typical AquabARRIER Detail
EC-10	Temporary Construction Drive
EC-11	Dewatering Detail and Size Chart
EC-12	Silt Saver Square Inlet Protection Detail
EC-14	Silt Saver Inlet Protection Model #S-200
EC-15	Silt Saver Inlet Protection Model #R-100
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ST-04	Straight Headwall with Flap Gate
ST-05	Isometric @ Headwall Type “I”
ST-06	Isometric @ Headwall Type “II”
ST-07	Manhole Solid Lid Casting Detail
ST-08	Chair Back Curb Inlet Casting
ST-09	Rolled Curb Inlet Casting
ST-10	Beehive Inlet Casting
ST-16	Structure Data Table
ST-23	Lake Cross Sections: Option 1
ST-24	Lake Cross Sections: Option 2
ST-25	Lake Cross Sections: Option 3
ST-26	Lake Outlet Detail For Lake Cross-Section Option 1
ST-27	Lake Outlet Detail For Lake Cross-Section Option 2
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ST-36	Typical Subsurface Drain (SSD) Lateral to Ind. Lots in Rear Yard Swale
ST-37	Subsurface Drain (SSD) Riser Detail
ST-38	Riser Locations
ST-39	Subsurface Drain (SSD) Detail When Within Dripline of Existing Trees
ST-40	Subsurface Drain (SSD) Detail No Swale
ST-41	Tile Clearing Through Woods
ST-42	Slotted Riser Inlet Details
ST-43	Typical Swale Detail
ST-44	Drain Outlet Detail #1
ST-45	Drain Outlet Detail #2

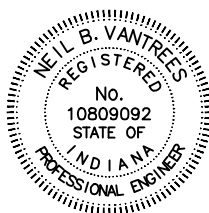
USE ONE
16' LIVESTOCK PANEL
WRAPPED W/ GEOTEXTILE FABRIC

30" MINIMUM HEIGHT

INSTALL 3 TO 4
6" T
STEEL FENCE POSTS



TEMPORARY DITCH INLET PROTECTION



CITY OF WESTFIELD, INDIANA

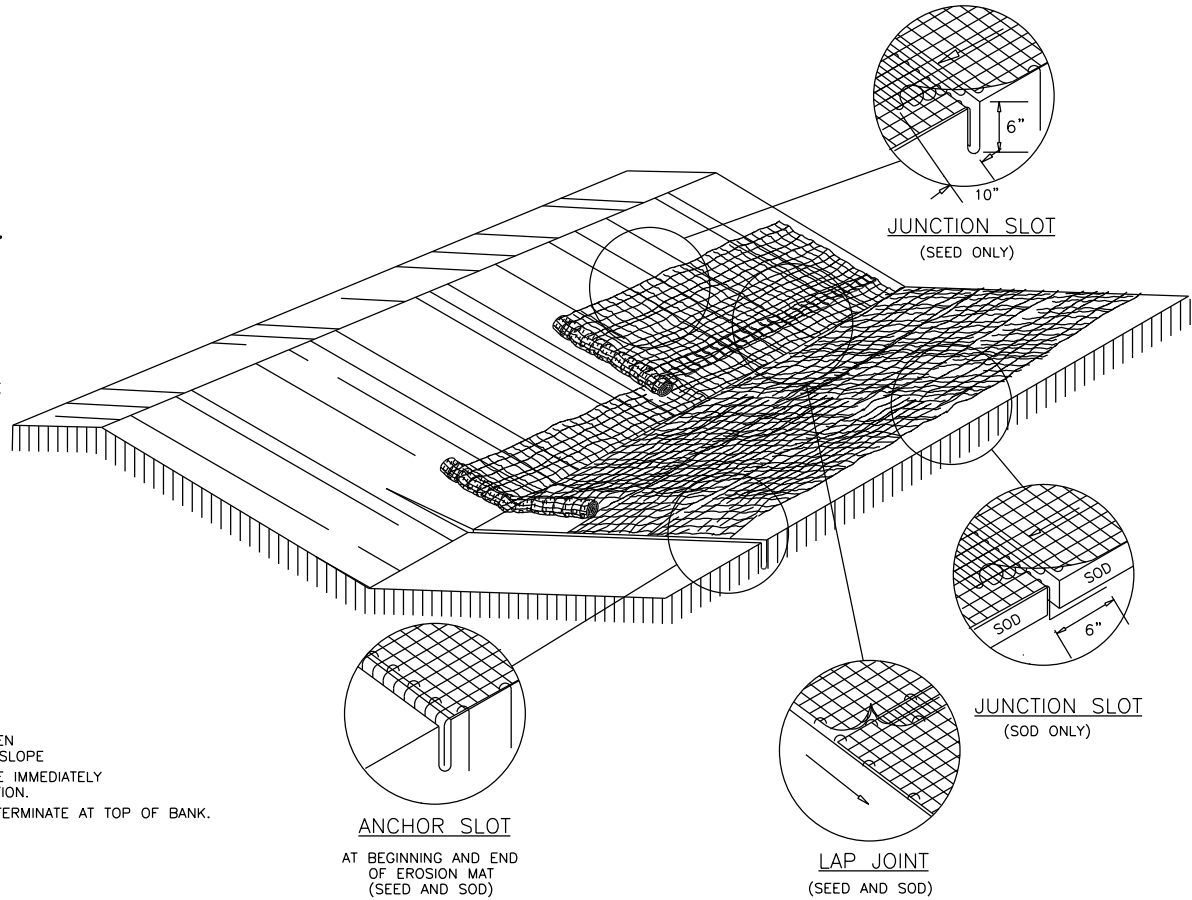
Neil B. Vantrees

4/1/13
DATE

FIGURE EC-1

GENERAL NOTES

1. PREPARE SOIL BEFORE INSTALLING BLANKETS, INCLUDING APPLICATION OF LIME, FERTILIZER AND SEED.
2. BEGIN AT THE TOP OF THE CHANNEL BY ANCHORING THE BLANKET IN A 6" DEEP x 6" WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
3. ROLL CENTER BLANKET IN DIRECTION OF WATER FLOW ON BOTTOM OF CHANNEL.
4. PLACE BLANKETS END OVER END (SHINGLE STYLE) WITH A 6" OVERLAP. USE A DOUBLE ROW OF STAGGERED STAPLES 4" APART TO SECURE BLANKETS.
5. FULL LENGTH EDGE OF BLANKETS AT TOP OF SIDE SLOPES MUST BE ANCHORED IN 6" DEEP x 6" WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
6. BLANKETS ON SIDE SLOPES MUST BE OVERLAPPED 4" OVER THE CENTER BLANKET AND STAPLED.
7. IN MEDIUM/HIGH FLOW CHANNEL APPLICATIONS, A STAPLE CHECK SLOT IS RECOMMENDED AT 30 TO 40 FOOT INTERVALS. USE A ROW OF STAPLES 4" APART OVER ENTIRE WIDTH OF THE CHANNEL. PLACE A SECOND ROW 4" BELOW THE FIRST ROW IN A STAGGERED PATTERN.
8. THE TERMINAL END OF THE BLANKETS MUST BE ANCHORED IN A 6" DEEP x 6" WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
8. BLANKET TYPE TO BE NORTH AMERICAN GREEN S75 OR S150 (OR SIMILAR) DEPENDING ON SLOPE
9. SILT FENCING INSTALLATION SHALL COMMENCE IMMEDIATELY FOLLOWING EROSION CONTROL MAT INSTALLATION.
10. EROSION CONTROL MAT SHALL BEGIN AND TERMINATE AT TOP OF BANK.



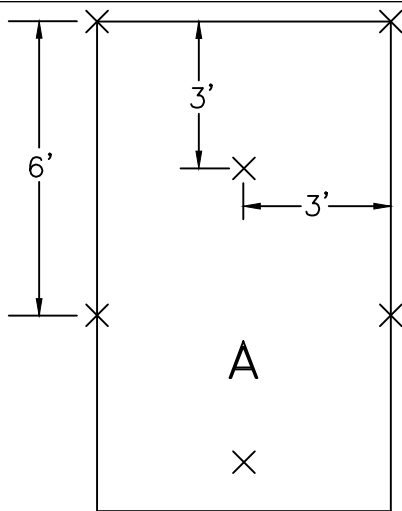
EROSION CONTROL MAT – SLOPE DETAIL



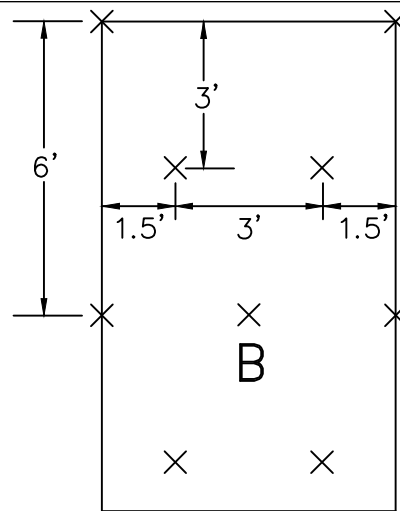
Phillip A. Sundling
2/25/15
DATE

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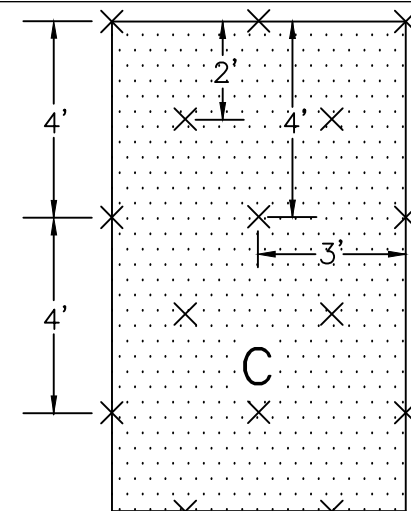
FIGURE EC-02



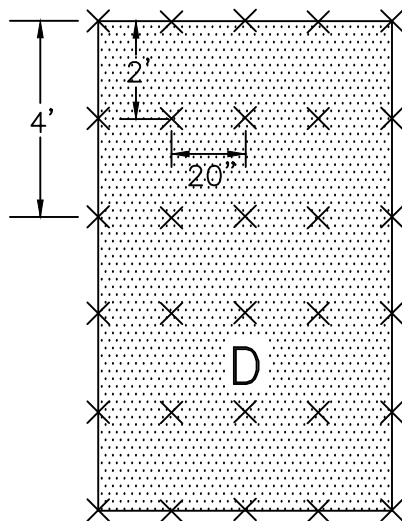
1 STAPLE PER SQ. YD.



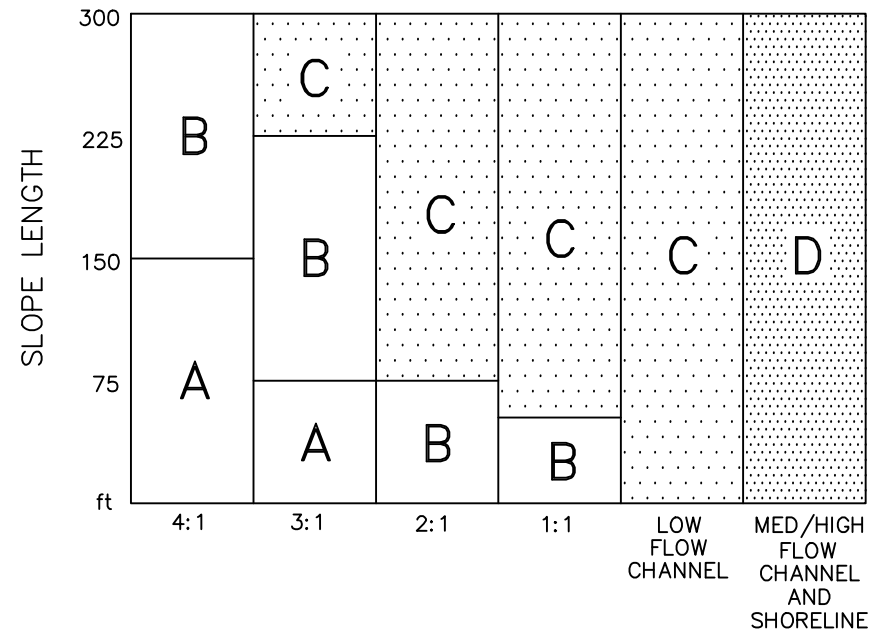
1.5 STAPLES PER SQ. YD.



2 STAPLES PER SQ. YD.



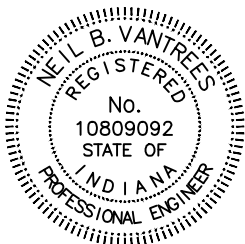
3.5 STAPLES PER SQ. YD.



SLOPE GRADIENT

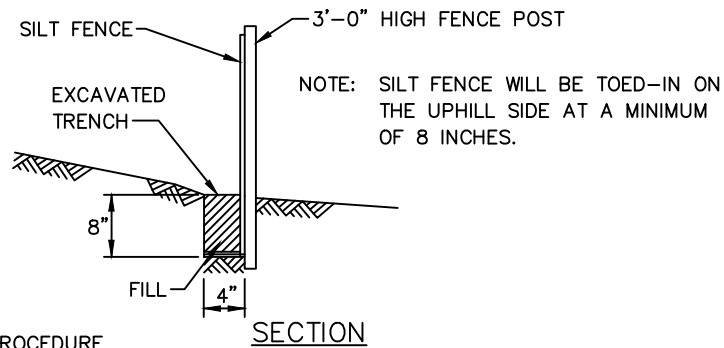
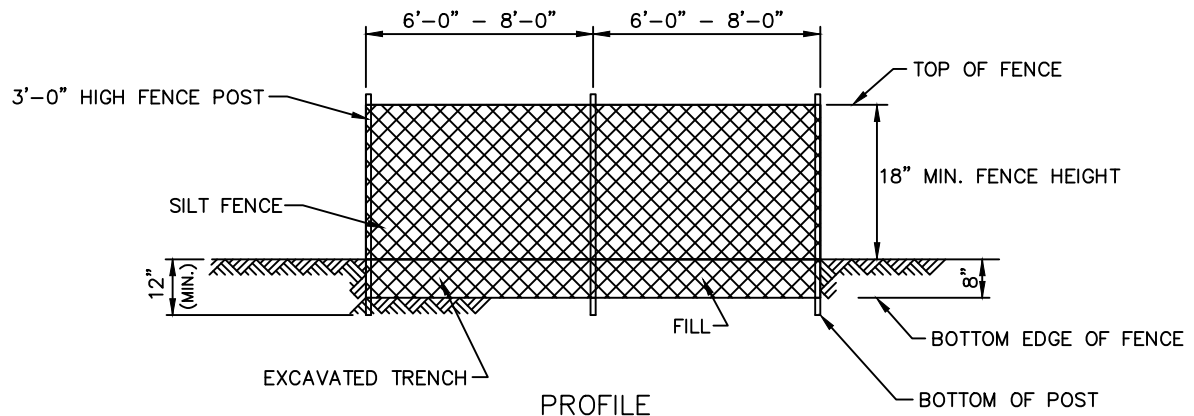
EROSION CONTROL MAT – STAPLE GUIDE

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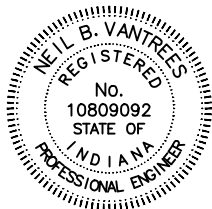
4/1/14
DATE



INSTALLATION PROCEDURE

1. 2" x 2" x 36" HARDWOOD OR STEEL FENCE POSTS ARE INSTALLED 6' APART (w/ EXTRA STRENGTH FABRIC WITHOUT WIRE BACKING) OR 8' APART (w/ WIRE BACKING), ON A SLIGHT ANGLE TOWARD THE ANTICIPATED RUNOFF SOURCE.
2. A TRENCH 4" WIDE BY 8" DEEP IS DUG ALONG THE UPHILL SIDE OF THE FENCE LINE.
3. THE SILT FENCE IS UNROLLED AND LAID OUT ALONG THE FENCE LINE.
4. AT THIS TIME THE LOWER 8" OF THE FENCE IS LAID IN THE TRENCH AND CURLED TOWARD THE EROSION SOURCE. THE TRENCH IS THEN BACKFILLED WITH SOIL.

SILT FENCE DETAIL

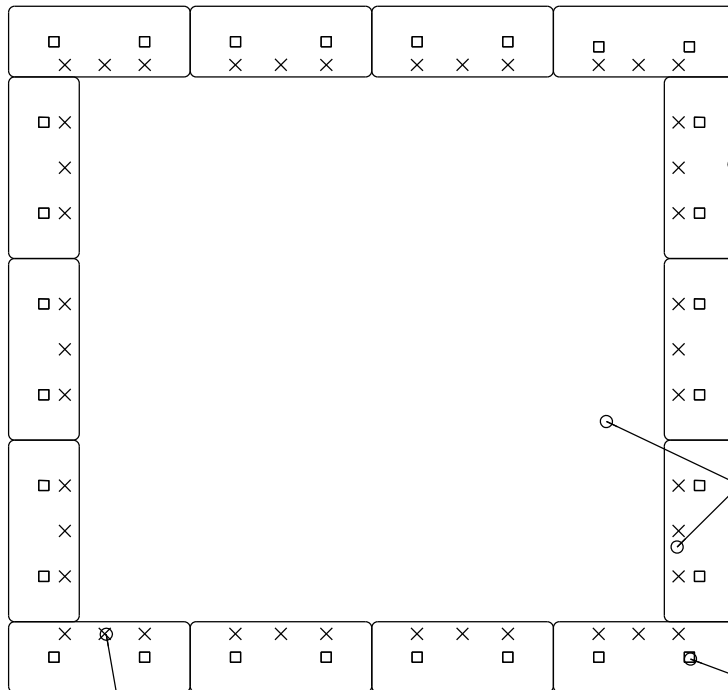


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FIGURE EC-4

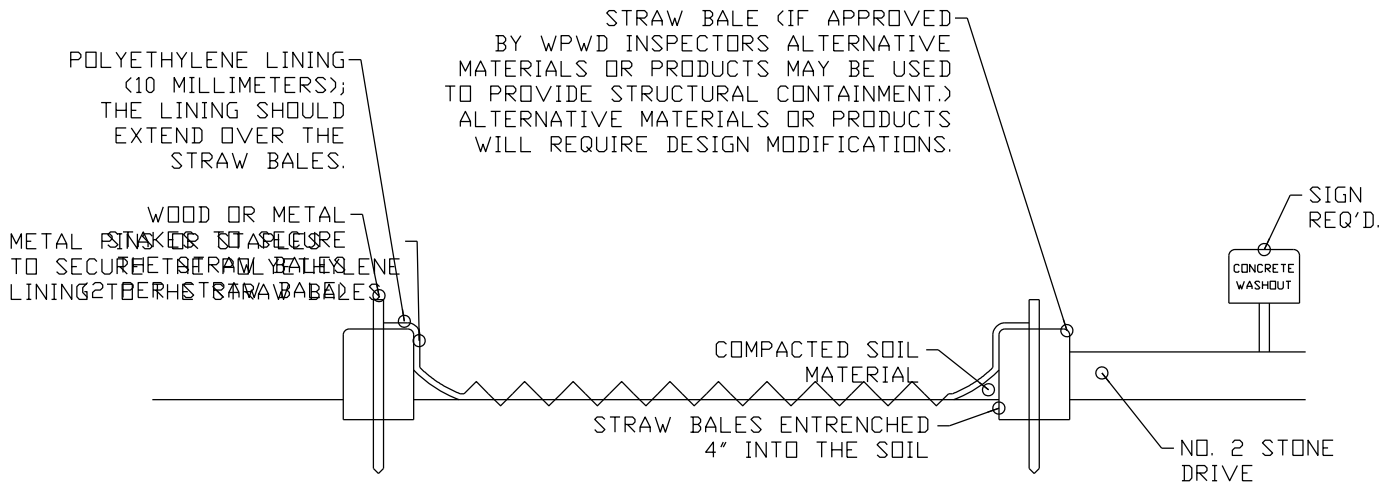


METAL PINS OR STAPLES
TO SECURE THE POLYETHYLENE
LINING TO THE STRAW BALES

STRAW BALE (IF APPROVED
BY WPWD INSPECTORS ALTERNATIVE
MATERIALS OR PRODUCTS MAY BE USED
TO PROVIDE STRUCTURAL CONTAINMENT.)
ALTERNATIVE MATERIALS OR PRODUCTS
WILL REQUIRE DESIGN MODIFICATIONS.

POLYETHYLENE LINING
(10 MILLIMETERS);
THE LINING SHOULD
EXTEND OVER THE
STRAW BALES.

WOOD OR METAL
STAKES TO SECURE
THE STRAW BALES
(2 PER STRAW BALE)



POLYETHYLENE LINING
(10 MILLIMETERS);
THE LINING SHOULD
EXTEND OVER THE
STRAW BALES.

STRAW BALE (IF APPROVED
BY WPWD INSPECTORS ALTERNATIVE
MATERIALS OR PRODUCTS MAY BE USED
TO PROVIDE STRUCTURAL CONTAINMENT.)
ALTERNATIVE MATERIALS OR PRODUCTS
WILL REQUIRE DESIGN MODIFICATIONS.

WOOD OR METAL
STAKES TO SECURE
THE STRAW BALES
(2 PER STRAW BALE)

COMPACTED SOIL
MATERIAL

STRAW BALES ENTRENCHED
4" INTO THE SOIL

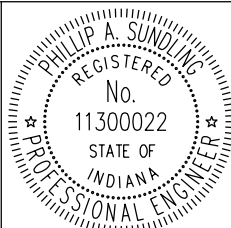
SIGN
REQ'D.

CONCRETE
WASHOUT

NO. 2 STONE
DRIVE

CONCRETE WASHOUT DETAIL

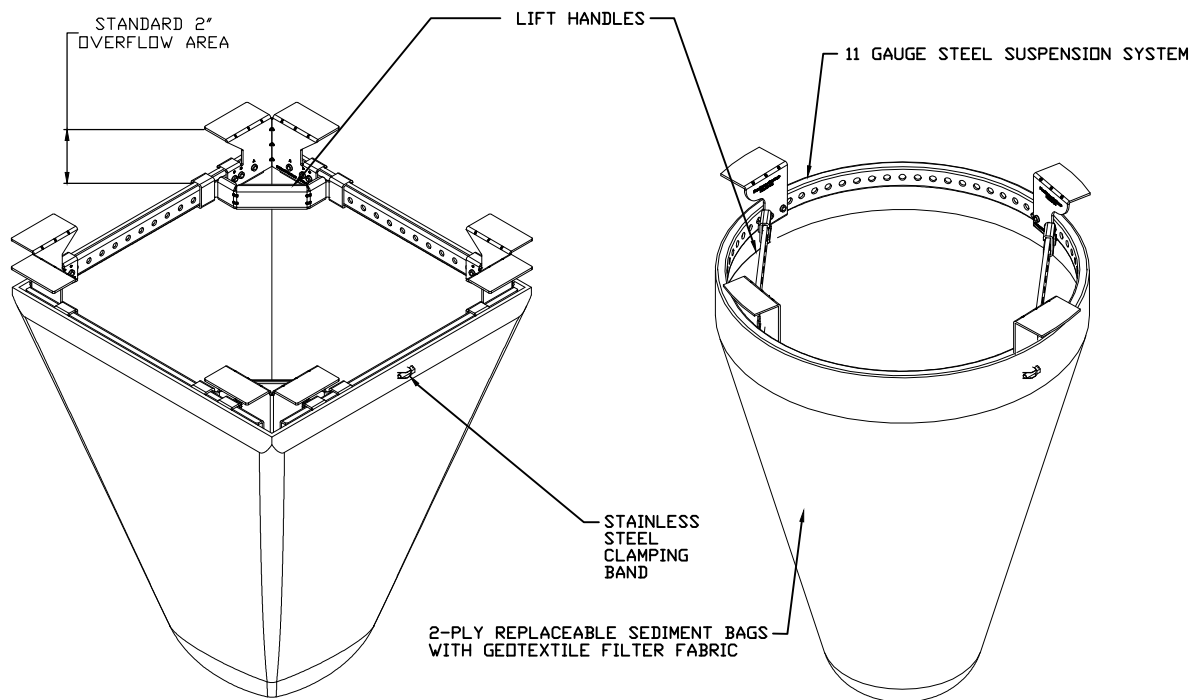
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Philip A. Sundling

2/12/16
DATE

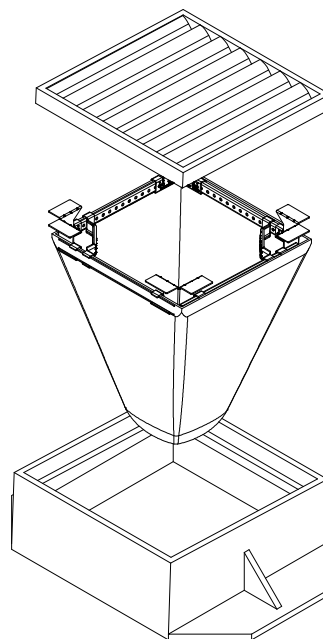
FIGURE EC-05



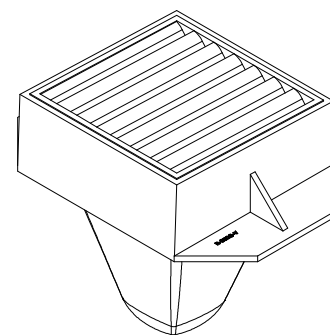
TYPICAL FLAT/RECTANGULAR/ROLLED CURB
INLET FILTER

TYPICAL ROUND
INLET FILTER

IPP FLeXstorm Inlet Filter Specifications			
Material Property	Test Method	Value (min ave)	
> Inner Filter Bag Specs (2 ft ³ min vol)		Non-Woven	Woven Mono
Grab Tensile	ASTM D 4632	100 lbs	200 lbs
Puncture Strength	ASTM D 4833	65 lbs	90 lbs
Trapezoidal Tear	ASTM D 4533	45 lbs	75 lbs
UV Resistance	ASTM D 4355	70% at 500 hrs	90%
App Open Size (AOS)	ASTM D 4751	70 sieve (.212 mm)	40 sieve (.425 mm)
Permittivity	ASTM D 4491	2.0 /sec	2.1/sec
Water Flow Rate	ASTM D 4491	145 gpm/sqft	145 gpm/sqft
> Polyester Outer Reinforcement Bag Specifications			
Weight	ASTM D 3776	4.55 oz/sqyd +/- 15%	
Thickness	ASTM D 1777	.040 +/- .005	
> Frame Construction			
A36 Structural Steel; 11 Gauge; Zinc Plated	ASTM A 576	Tensile Strength > 58,000 psi; Yield Strength > 36,000 psi	



INSTALLATION:
 1. REMOVE GRATE
 2. DROP INLET FILTER ONTO
 LOAD BEARING LIP OF CASTING OR
 CONCRETE STRUCTURE
 3. REPLACE GRATE



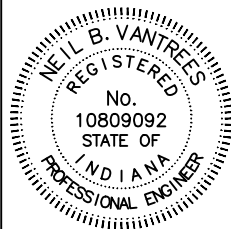
INLET PROTECTION

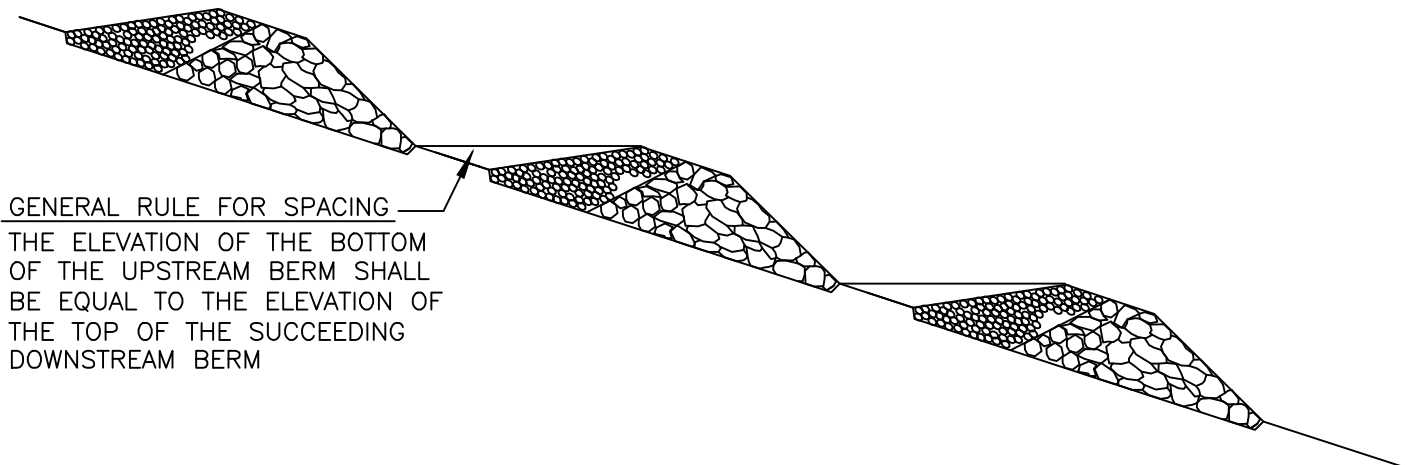
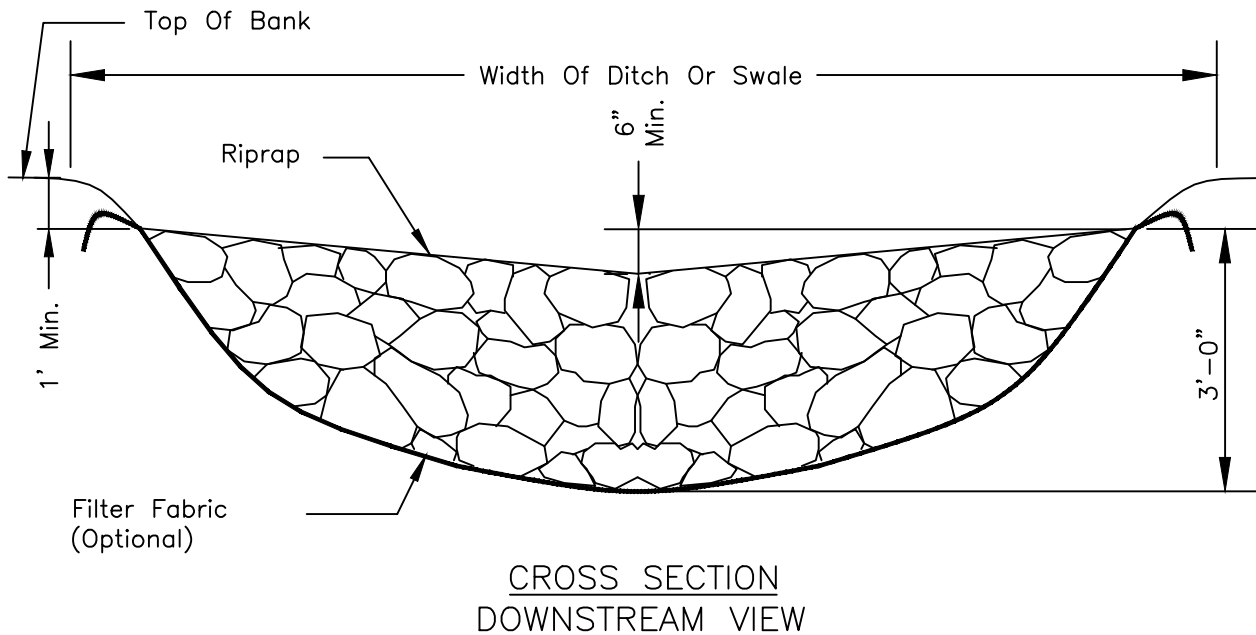
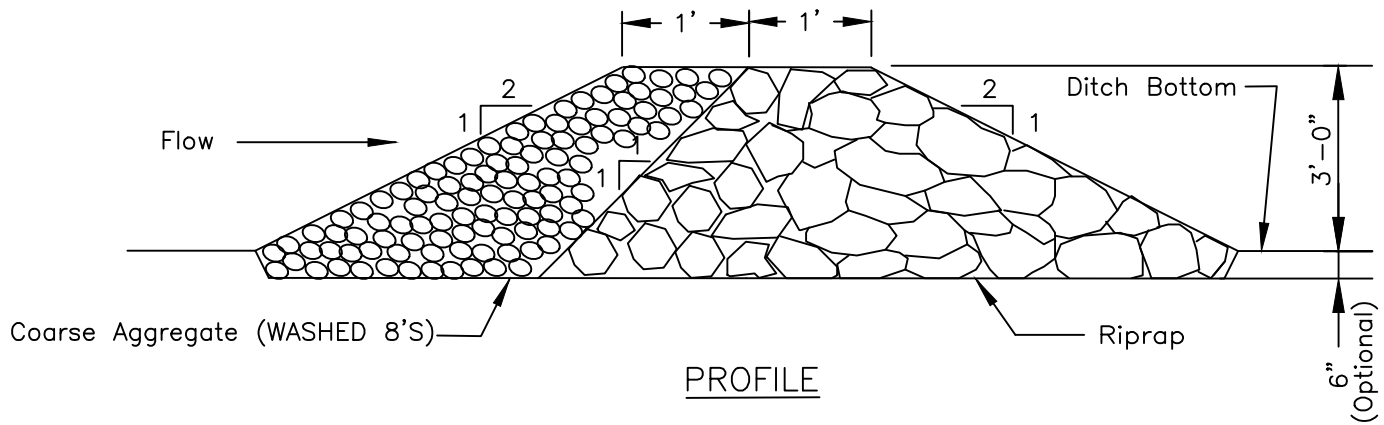
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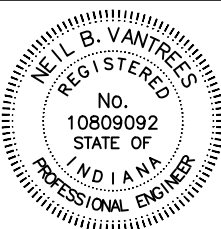
4/1/13
DATE

FIGURE EC-6





ROCK CHECK DAM – RIPRAP

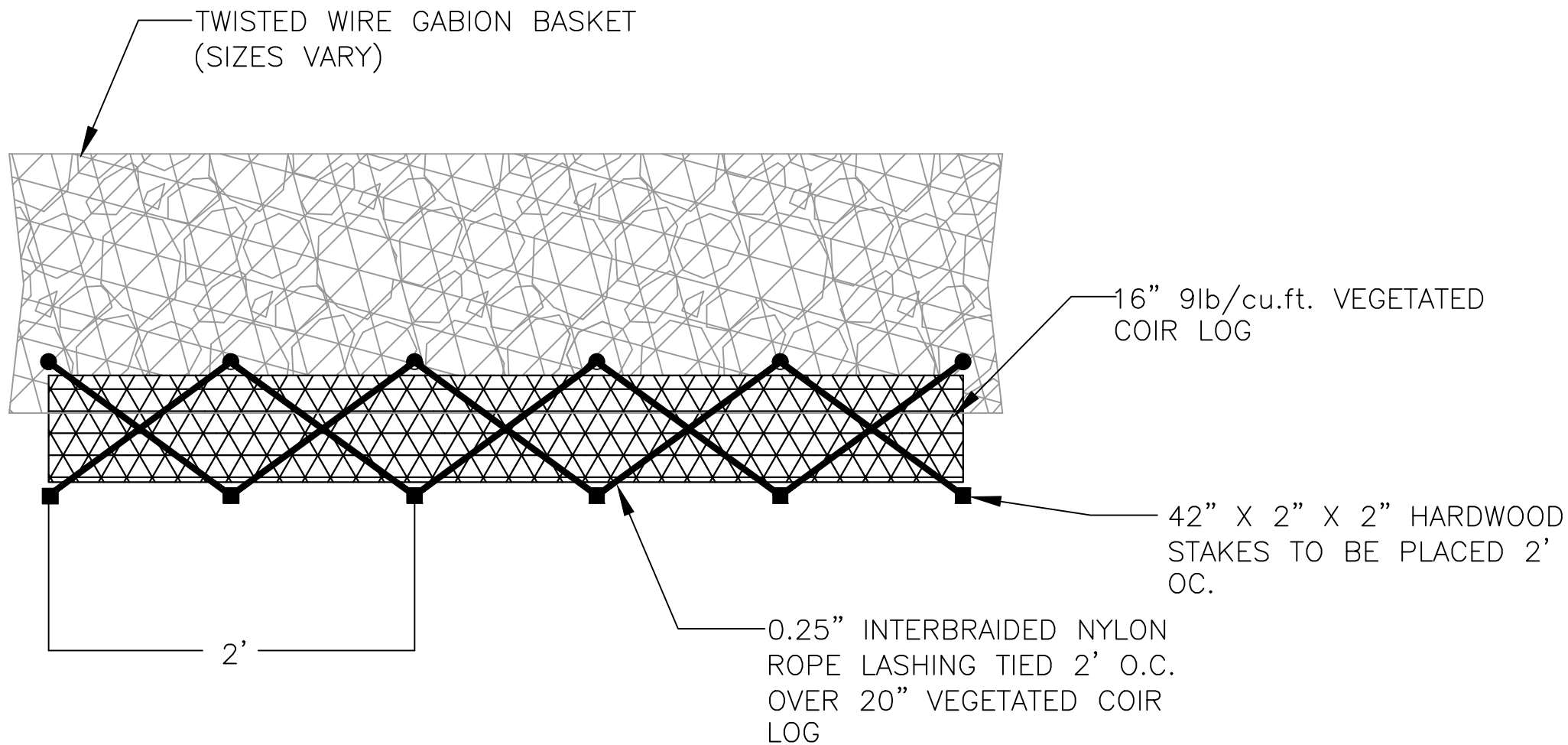


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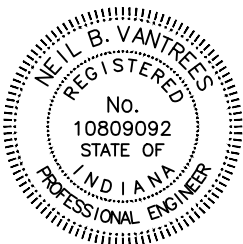
4/1/13
DATE

FIGURE EC-7



GABION ANCHOR DETAIL

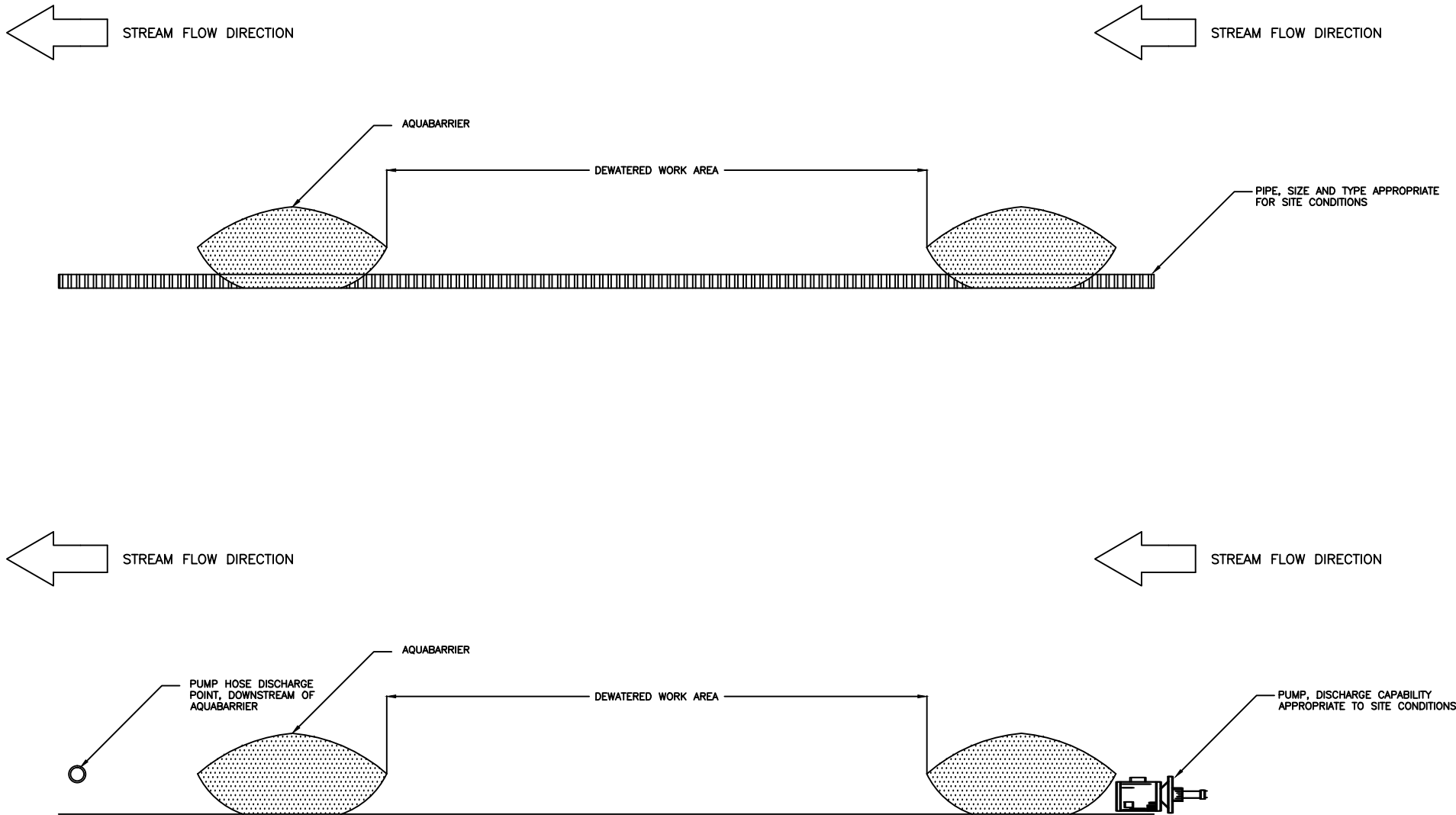
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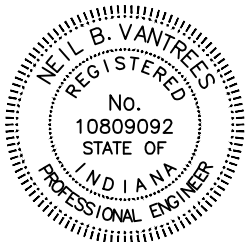
4/1/14
DATE

FIGURE EC-08



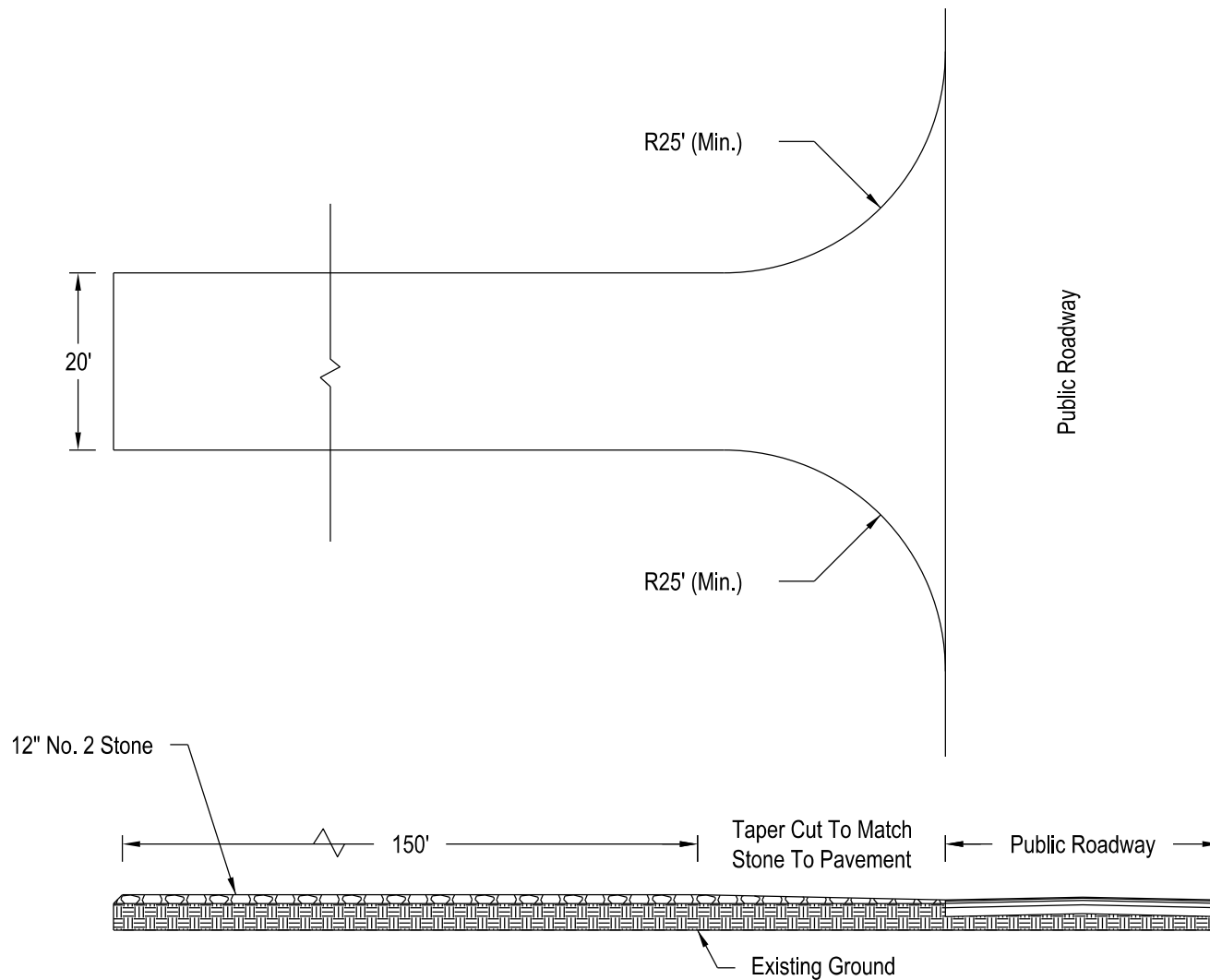
TYPICAL AQUABARRIER DETAIL

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DATE



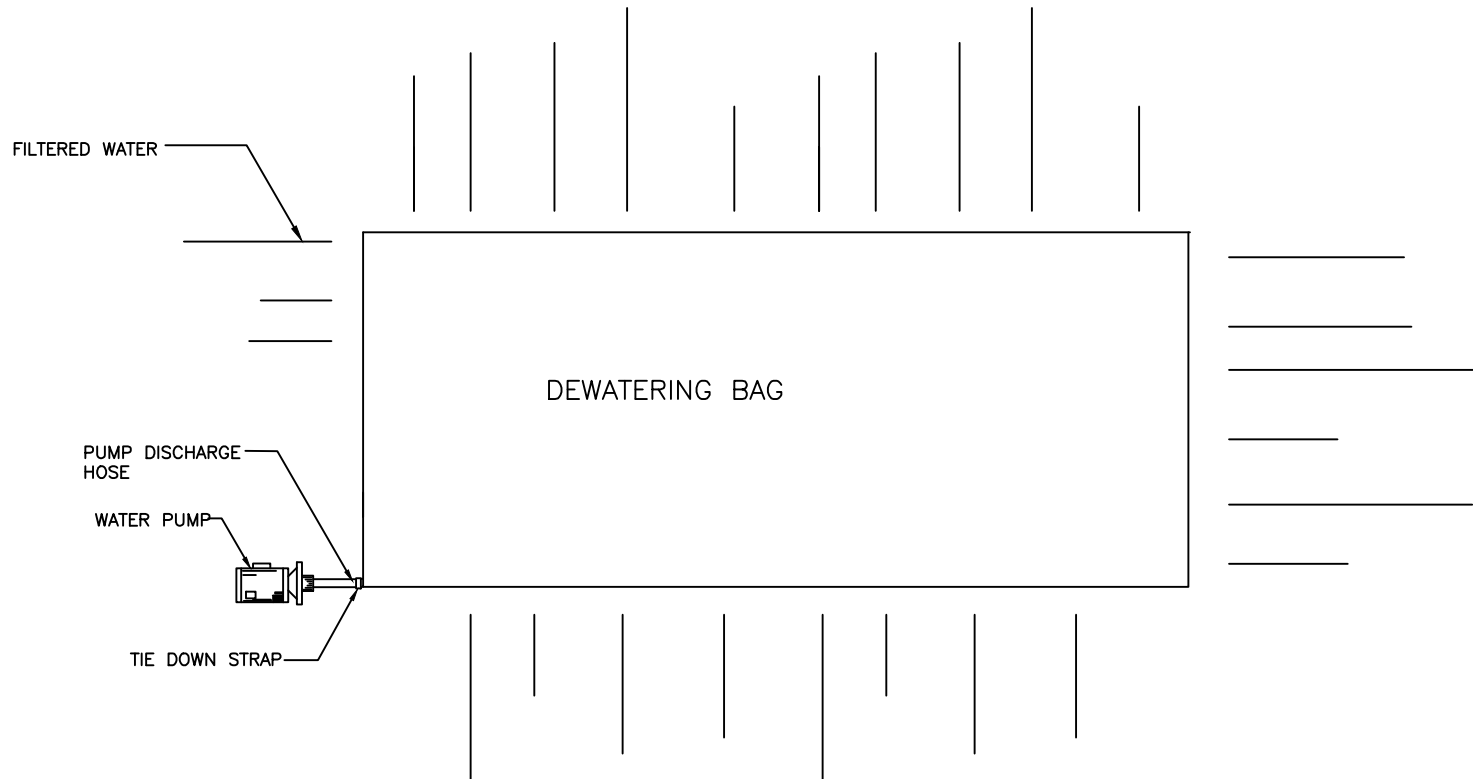
TEMPORARY CONSTRUCTION DRIVE



[Signature]
2/26/16
DATE

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INDIANA

FIGURE EC-10



Dewatering Filtration Bag Size	Maximum Gallon Per Minute Capacity
4' x 6'	228
7.5' x 7.5'	534
10' x 10'	950
10' x 15'	1,425
15' x 15'	2,137
15' x 30'	4,275
15' x 65'	9,262

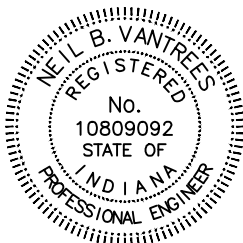
INSTALLATION AND MAINTENANCE GUIDELINES

INSTALLATION: PLACE LIFTING STRAPS (NOT INCLUDED) UNDER THE UNIT TO FACILITATE REMOVAL AFTER USE. UNFOLD D2 DEWATERING BAG ON A STABILIZED AREA OVER DENSE VEGETATION, STRAW OR OTHER COVER. PLACE BAG OVER OPEN GRADED STONE TO ACHIEVE MAXIMUM FILTRATION AND DRAINAGE. INSERT DISCHARGE HOSE FROM PUMP INTO D2 DEWATERING BAG A MINIMUM OF SIX INCHES AND TIGHTLY SECURE WITH THE ATTACHED STRAP TO PREVENT WATER FROM FLOWING OUT OF THE UNIT WITHOUT BEING FILTERED. IF USING OPTIONAL ABSORBENTS, PLACE ABSORBENT BOOM INTO THE D2 DEWATERING BAG. CLIP ABSORBENT BOOM TO TETHER PROVIDED INSIDE THE UNIT.

MAINTENANCE: REPLACE THE UNIT WHEN $\frac{1}{2}$ FULL OF SEDIMENT OR WHEN SEDIMENT HAS REDUCED THE FLOW RATE OF THE PUMP DISCHARGE TO AN IMPRACTICAL RATE. IF USING OPTIONAL OIL ABSORBENTS; REMOVE AND REPLACE ABSORBENT WHEN NEAR SATURATION.

DEWATERING DETAIL AND SIZE CHART

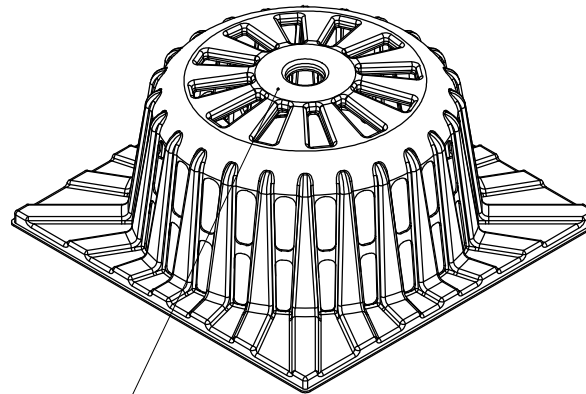
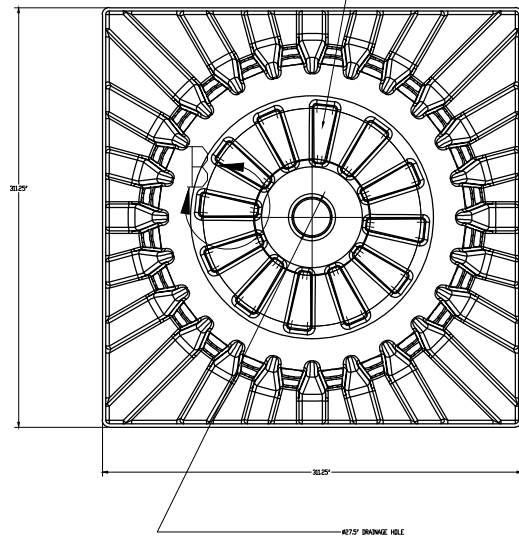
CITY OF WESTFIELD, INDIANA



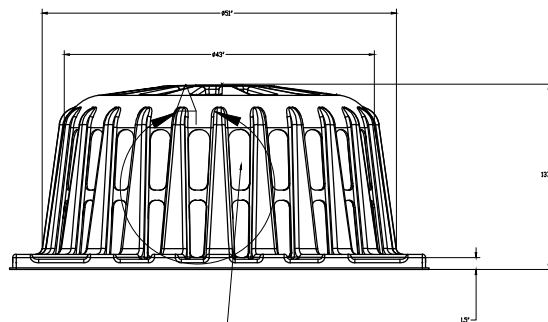
Neil B. Vantrees

4/1/14
DATE

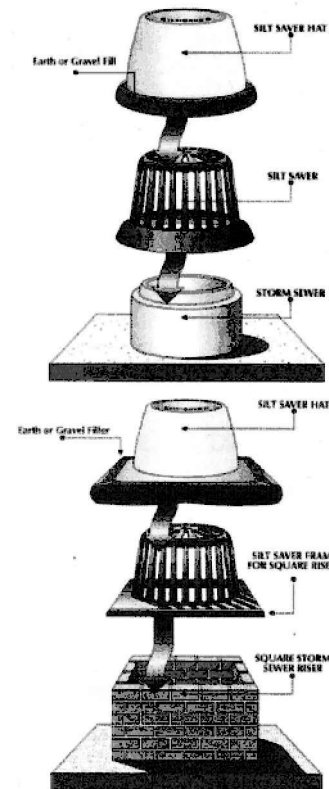
TWELVE DRAINAGE SLOTS IN TOP



SILT-SAVER LOGO AND PATENT NO. MOLDED INTO PART. SILT-SAVER LABEL IS PLACED OVER LOGO AREA ON OUTSIDE OF PART.



FORTY EIGHT DRAINAGE SLOTS AROUND PERIMETER

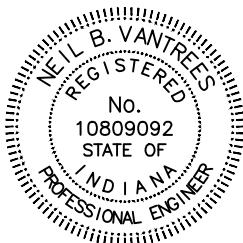


Weight	D-3776	3.0 oz y ²
Tensile strength	D-4632	80lbs
Elongation	D-4632	50%
Mullen burst	D-3786	150
Puncture strength	D-4833	50
Trapezoid tear	D-4533	30
AOS-US std sieve	D-4751	70
Permittivity, -1 *	D-4491	2.0
Flow *	D-4491	102 gal/min/ft ²
U.V. Resistance, %	D-4355 (500 hrs)	70

* Due to the variations in soil conditions, (soil types, soil stability, etc.) Silt-Saver, Inc. does not specify long-term effectiveness, (resistance to clogging). If this is a concern, one may want to conduct a gradient ratio test that will compare a specific soils hydraulic gradient to the hydraulic through the filter.

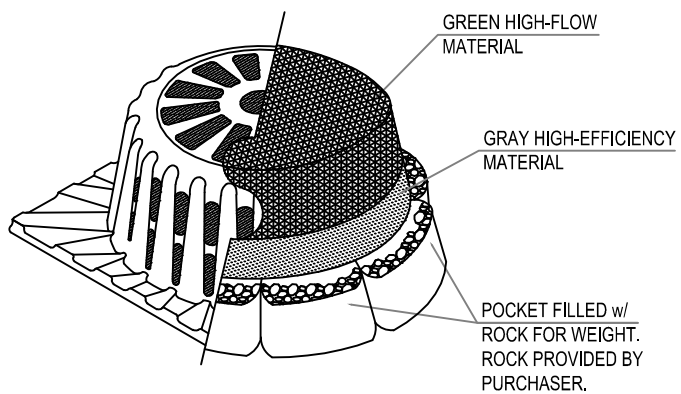
SILT SAVER SQUARE INLET PROTECTION DETAIL

CITY OF WESTFIELD, INDIANA



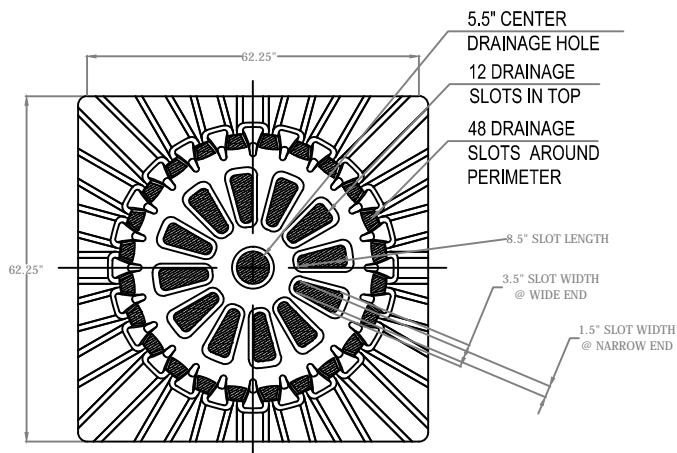
Neil B. Vantrees

4/1/14
DATE

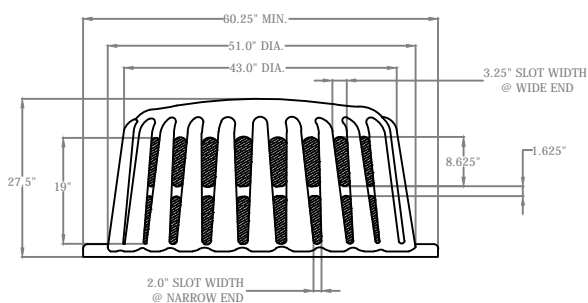


ISOMETRIC VIEW

SHOWN WITH ROADWAY PROJECTS FILTER HAT



PLAN VIEW



ELEVATION VIEW

REPLACEMENT FILTERS: MODEL # S-240

FILTER OPTIONS

FILTER HAT IS AVAILABLE IN THREE OPTIONS:

- 1) ALL HIGH-FLOW MATERIAL
 - 2) ALL HIGH-EFFICIENCY MATERIAL
 - 3) HIGH-FLOW MATERIAL ON TOP HALF OF HAT, HIGH-EFFICIENCY MATERIAL ON BOTTOM HALF (THIS FILTER COVER IS RECOMMENDED FOR ALL ROADWAY PROJECTS.)
- IT IS THE PURCHASERS RESPONSIBILITY TO PURCHASE APPROPRIATE FILTER HAT. PURCHASER SHALL PROVIDE ROCK FOR FILTER POCKETS.

FILTER HAT INSTALLATION

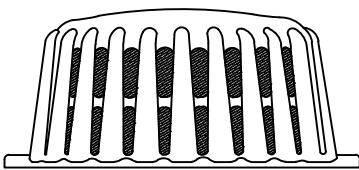
FILTER HAT SLIDES DIRECTLY OVER FILTER FRAME. TO KEEP FILTER FRAME IN PLACE OVER STORM STRUCTURE, ROCK POCKETS ARE SEWN DIRECTLY INTO FILTER HAT MATERIAL. EVERY FILTER HAT COMES IN ONE PIECE FOR EASY INSTALLATION.

MAINTENANCE

ALL TEMPORARY EROSION, SEDIMENTATION, & POLLUTION CONTROL PRACTICES SHOULD BE INSPECTED DAILY. CONTRACTOR SHALL REMOVE SEDIMENT AND DISPOSE OF IN A PROPER MANNER. INSPECT S-200A DAILY FOR CUTS, ABRASIONS, AND PROPER INSTALLATION. REPLACE OR REPOSITION AS NECESSARY.

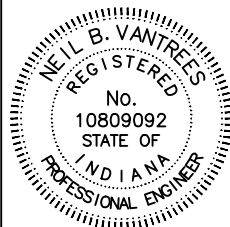
SPECIFICATIONS

FILTER FABRIC SILT-SAVER HAT SHALL BE BASED ON DESIGN PROFESSIONAL'S SPECIFICATIONS.

					
HEAD - 3.0'					
2.5'					
2.0'					
1.5'					
1.0'					
0.5'					
0.0'					
FRAME & FILTER DISCHARGE ANALYSIS					
HEAD (FT)	EQUATION USED	OPENING AREA (SF)	FRAME FLOW (CFS)	FILTER AREA (SF)	FILTERED FLOW (CFS)
0.5	O	2.1	7	6	2
1.0	O	3.9	19	12	3
1.5	O	7.0	41	18	5
2.0	O	8.0	54	24	7
2.5	O	9.2	70	30	9
3.0	O	9.2	77	—	77
<p>DUE TO NARROW SLOT, A TRANSITION WILL OCCUR BETWEEN WEIR AND ORIFICE CONDITIONS. ORIFICE FLOW WILL PROVIDE A MORE CONSERVATIVE ESTIMATE OF FLOW, THEREFORE THE LESSER OF THE ORIFICE AND WEIR FLOWS WILL BE USED FOR EACH STAGE CALCULATION.</p> <p>FILTER MATERIAL ALLOWS 129 gpm/SF OR 0.29cfs/SF</p> <p>ORIFICE EQUATION (O) = $Q = 0.6A(2gh)^{0.5}$</p> <p>P = FEET PERIMETER</p> <p>h = HEAD IN FEET</p> <p>Q = CAPACITY IN cfs</p> <p>A = FREE OPEN AREA OF FRAME</p> <p>g = 32.2 FEET-PER-SECOND/SECOND</p>					

SILT SAVER INLET PROTECTION MODEL #S-200

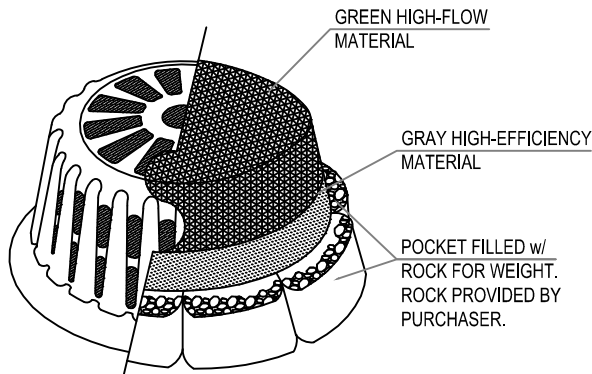
CITY OF WESTFIELD, INDIANA



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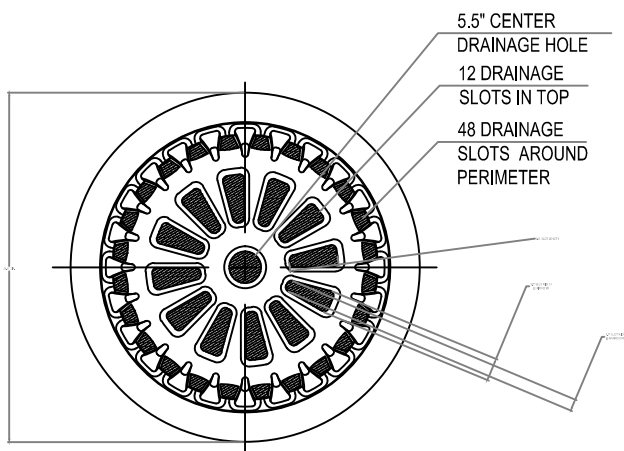
4/1/14
DATE

FIGURE EC-14

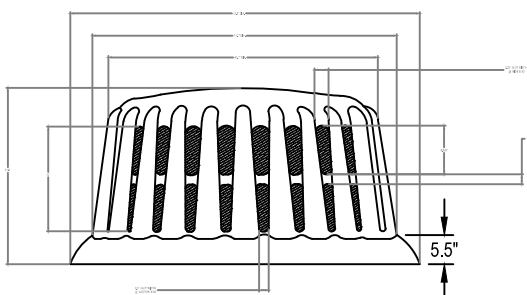


ISOMETRIC VIEW

SHOWN WITH ROADWAY PROJECTS FILTER HAT



PLAN VIEW



ELEVATION VIEW

REPLACEMENT FILTERS: MODEL # R-140

FILTER OPTIONS

FILTER HAT IS AVAILABLE IN THREE OPTIONS:

- 1) ALL HIGH-FLOW MATERIAL
- 2) ALL HIGH-EFFICIENCY MATERIAL
- 3) HIGH-FLOW MATERIAL ON TOP HALF OF HAT, HIGH-EFFICIENCY MATERIAL ON BOTTOM HALF (THIS FILTER COVER IS RECOMMENDED FOR ALL ROADWAY PROJECTS.)

IT IS THE PURCHASERS RESPONSIBILITY TO PURCHASE APPROPRIATE FILTER HAT. PURCHASER SHALL PROVIDE ROCK FOR FILTER POCKETS.

FILTER HAT INSTALLATION

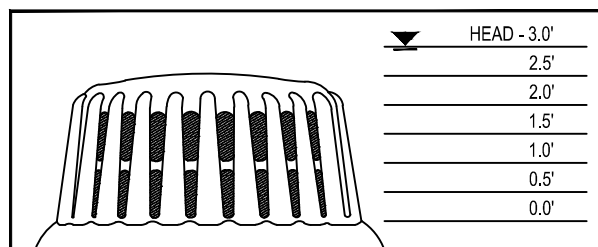
FILTER HAT SLIDES DIRECTLY OVER FILTER FRAME. TO KEEP FILTER FRAME IN PLACE OVER STORM STRUCTURE, ROCK POCKETS ARE SEWN DIRECTLY INTO FILTER HAT MATERIAL. EVERY FILTER HAT COMES IN ONE PIECE FOR EASY INSTALLATION.

MAINTENANCE

ALL TEMPORARY EROSION, SEDIMENTATION, & POLLUTION CONTROL PRACTICES SHOULD BE INSPECTED DAILY. CONTRACTOR SHALL REMOVE SEDIMENT AND DISPOSE OF IN A PROPER MANNER. INSPECT R-100A DAILY FOR CUTS, ABRASIONS, AND PROPER INSTALLATION. REPLACE OR REPOSITION AS NECESSARY.

SPECIFICATIONS

FILTER FABRIC SILT-SAVER HAT SHALL BE BASED ON DESIGN PROFESSIONAL'S SPECIFICATIONS.



FRAME & FILTER DISCHARGE ANALYSIS

HEAD (FT)	EQUATION USED	OPENING AREA (SF)	FRAME FLOW (CFS)	FILTER AREA (SF)	FILTERED FLOW (CFS)
0.5	O	2.1	7	6	2
1.0	O	3.9	19	12	3
1.5	O	7.0	41	18	5
2.0	O	8.0	54	24	7
2.5	O	9.2	70	30	9
3.0	O	9.2	77	—	77

DUE TO NARROW SLOT, A TRANSITION WILL OCCUR BETWEEN WEIR AND ORIFICE CONDITIONS. ORIFICE FLOW WILL PROVIDE A MORE CONSERVATIVE ESTIMATE OF FLOW, THEREFORE THE LESSER OF THE ORIFICE AND WEIR FLOWS WILL BE USED FOR EACH STAGE CALCULATION.

FILTER MATERIAL ALLOWS 129 gpm/SF OR 0.29cfs/SF

ORIFICE EQUATION (O) = $Q = 0.6A(2gh)^{0.5}$

P = FEET PERIMETER

h = HEAD IN FEET

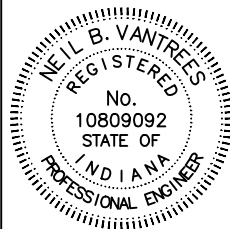
Q = CAPACITY IN cfs

A = FREE OPEN AREA OF FRAME

g = 32.2 FEET-PER-SECOND/SECOND

SILT SAVER INLET PROTECTION MODEL #R-100

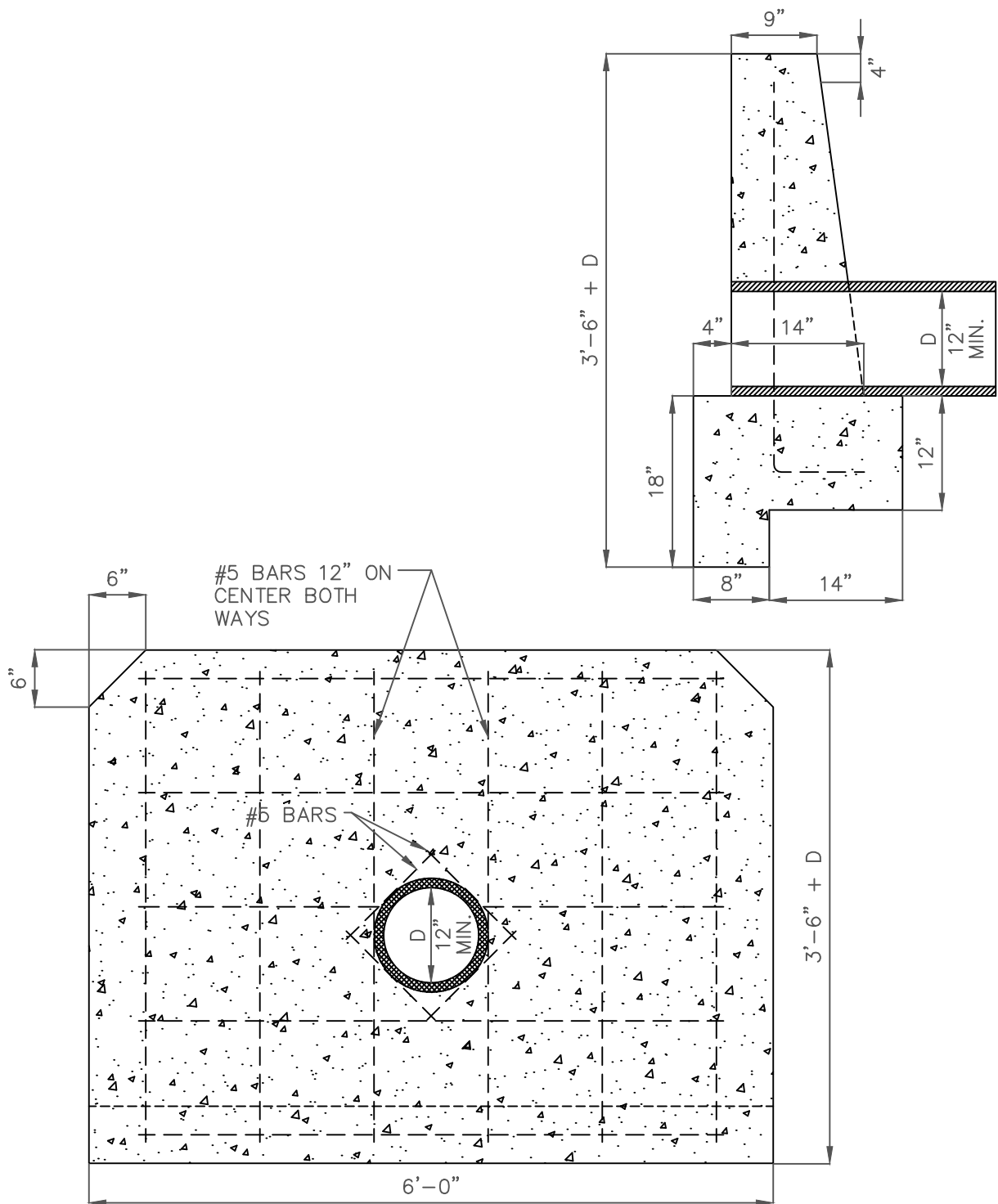
CITY OF WESTFIELD, INDIANA



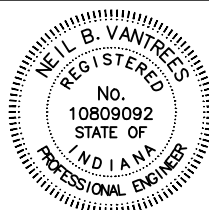
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FIGURE EC-15



STRAIGHT HEADWALL



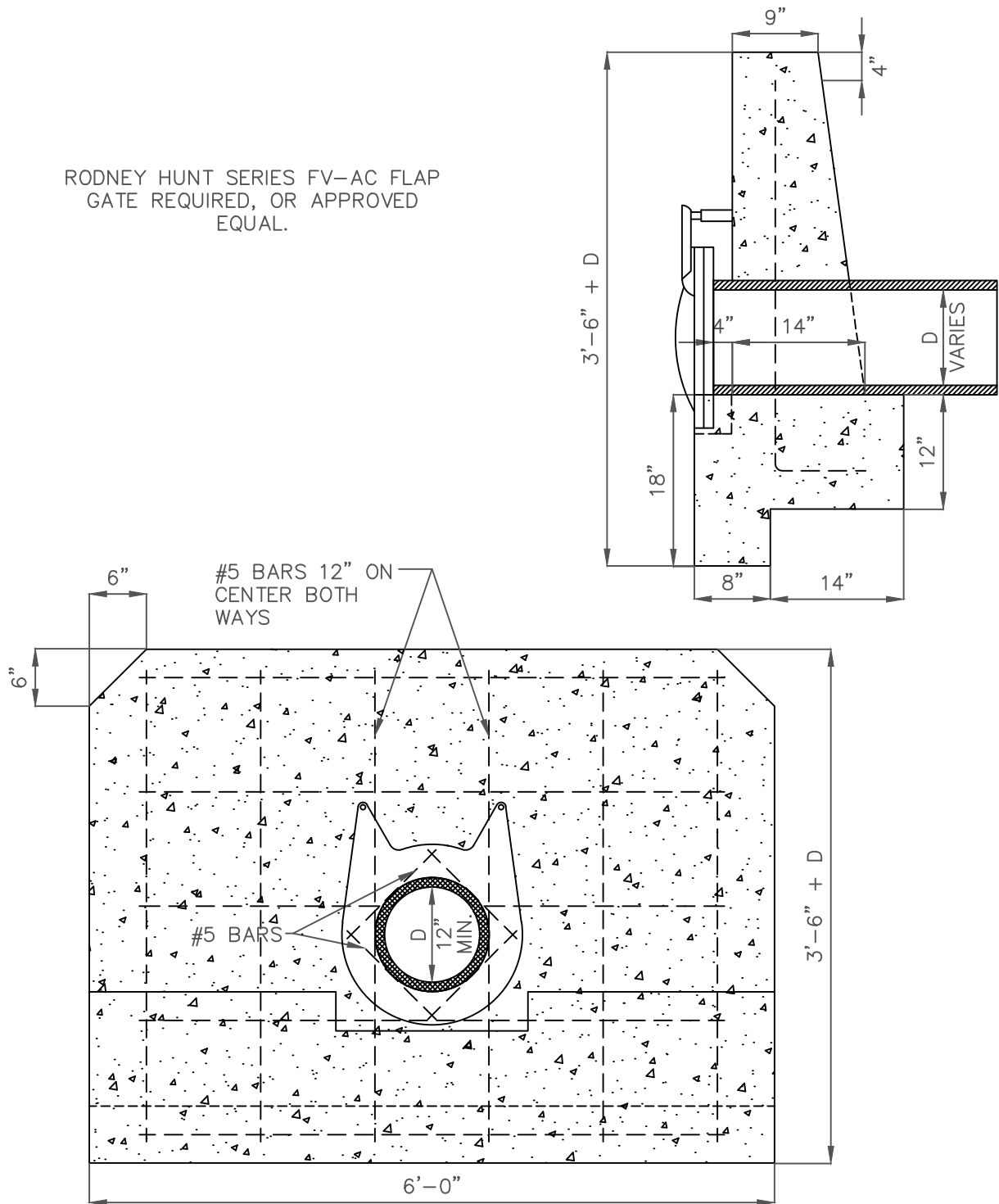
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4/1/14
DATE

FIGURE ST-3

RODNEY HUNT SERIES FV-AC FLAP
GATE REQUIRED, OR APPROVED
EQUAL.



STRAIGHT HEADWALL WITH FLAP GATE

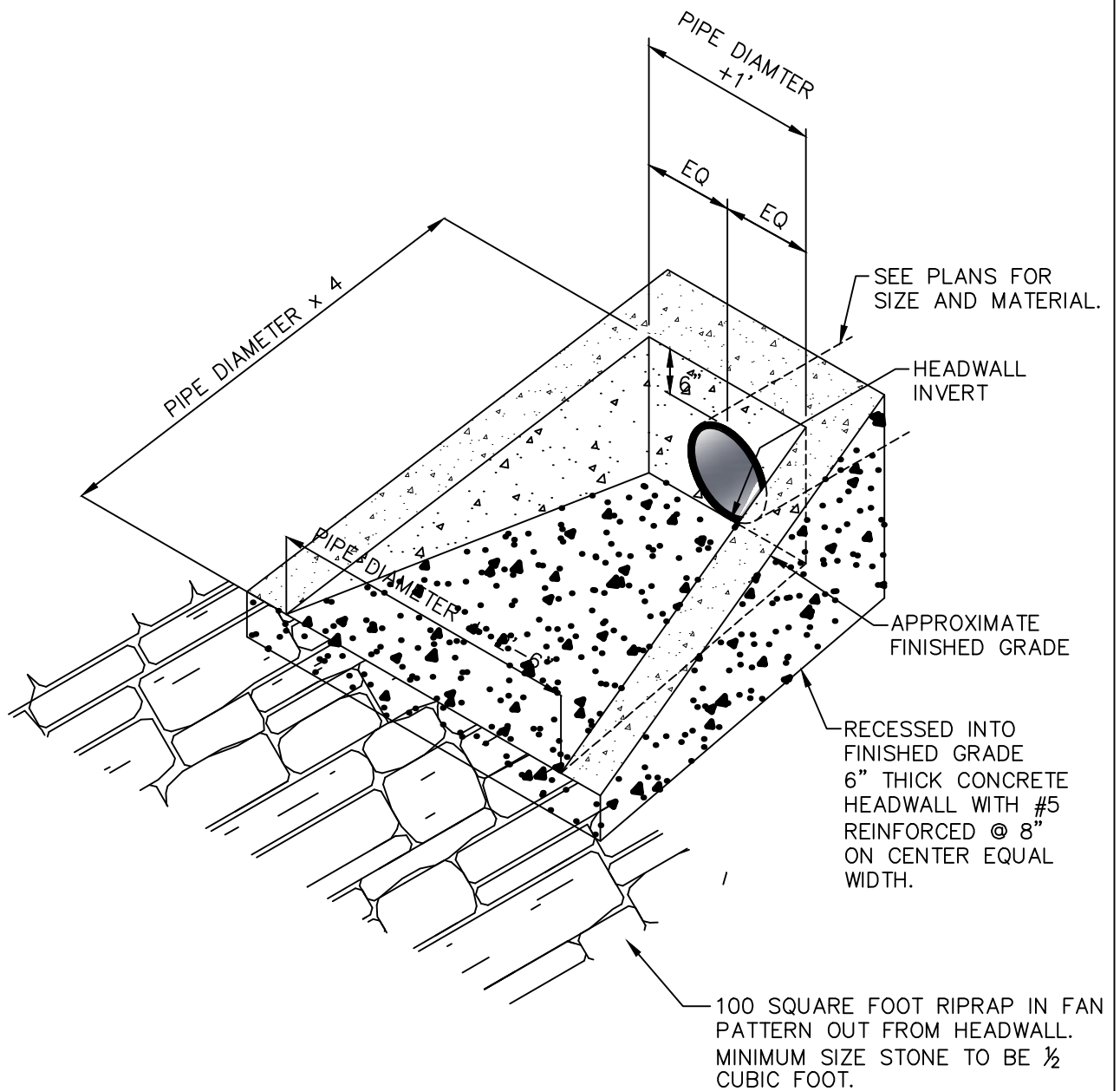


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FIGURE ST-4



ISOMETRIC @ HEADWALL TYPE "I"

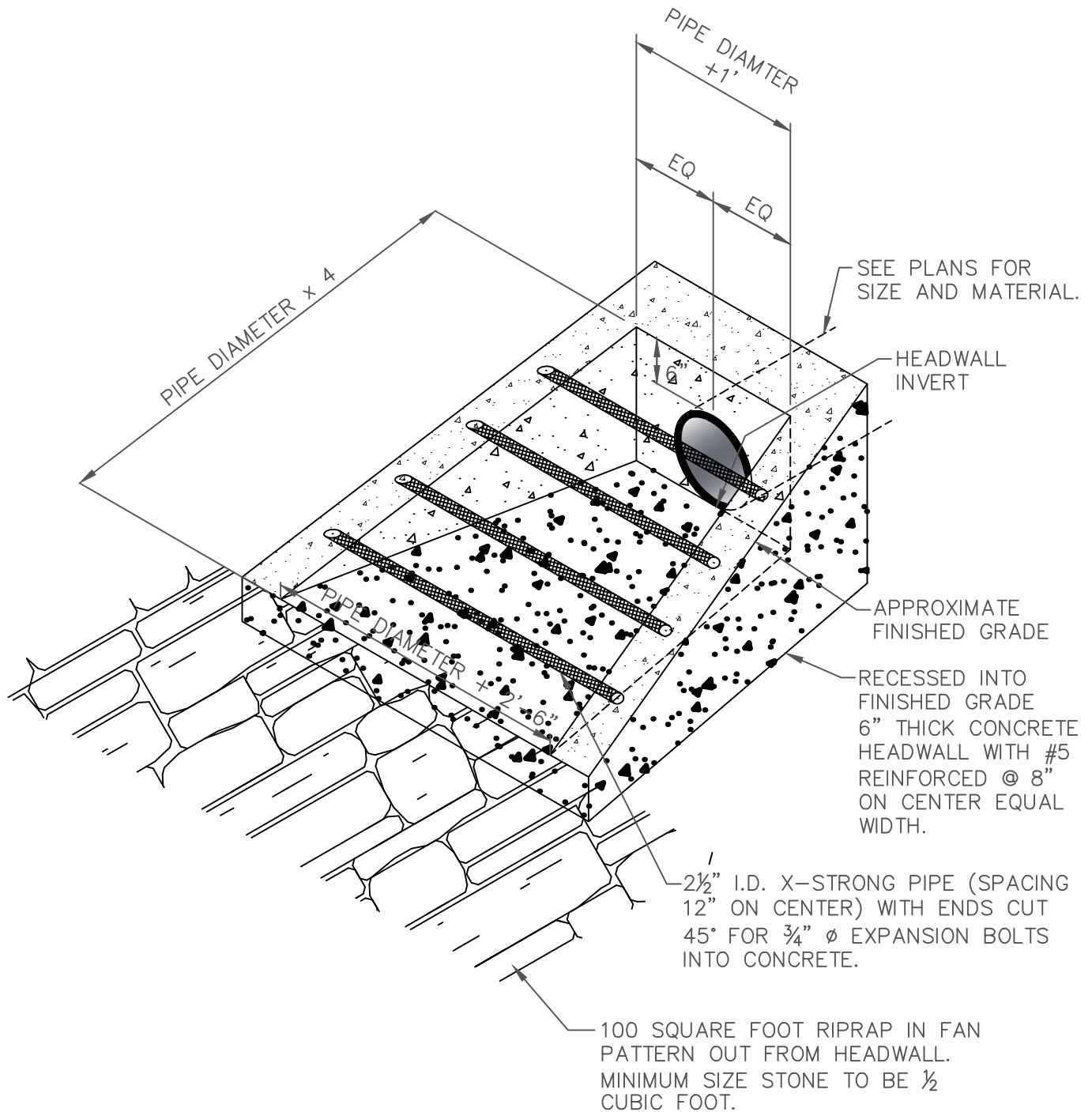


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FIGURE ST-5



NOTE: HEADWALL SIMILAR TO TYPE "I" EXCEPT FOR PIPE GUARDS

ISOMETRIC @ HEADWALL TYPE "II"

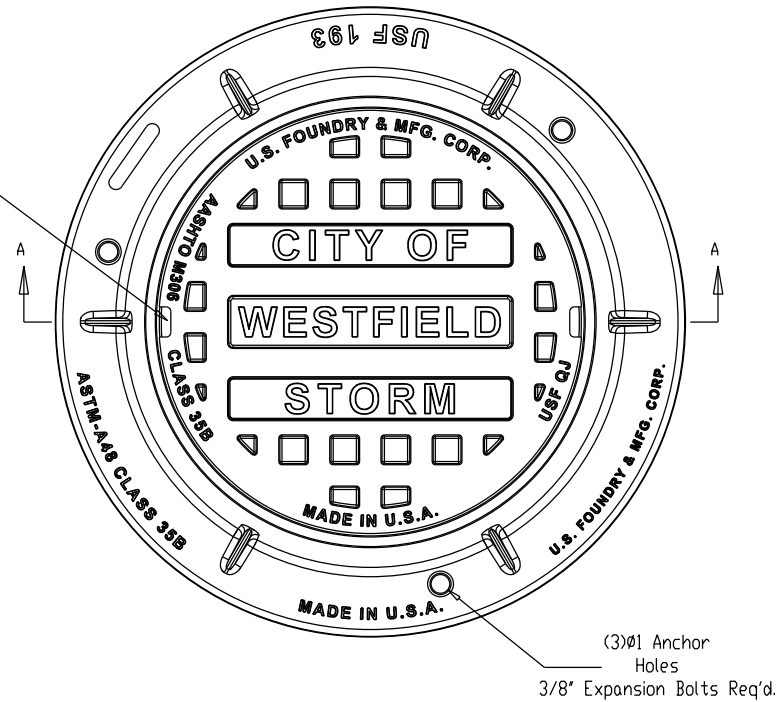
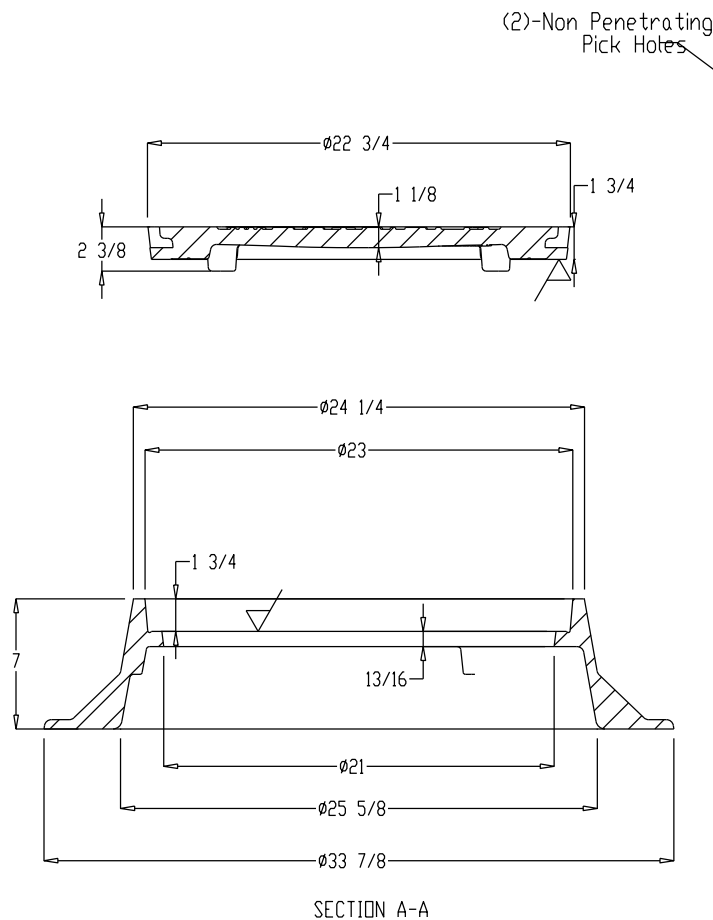


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FIGURE ST-6



NEENAH	R-1642
EAST JORDAN	1045Z
USF	755-NC

MANHOLE SOLID LID CASTING DETAIL

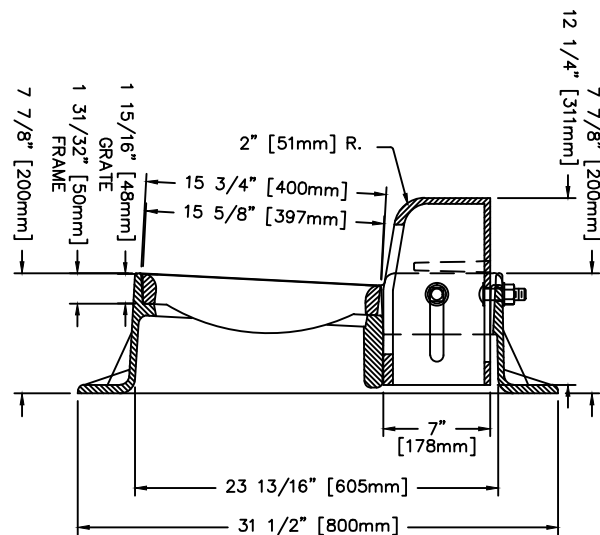
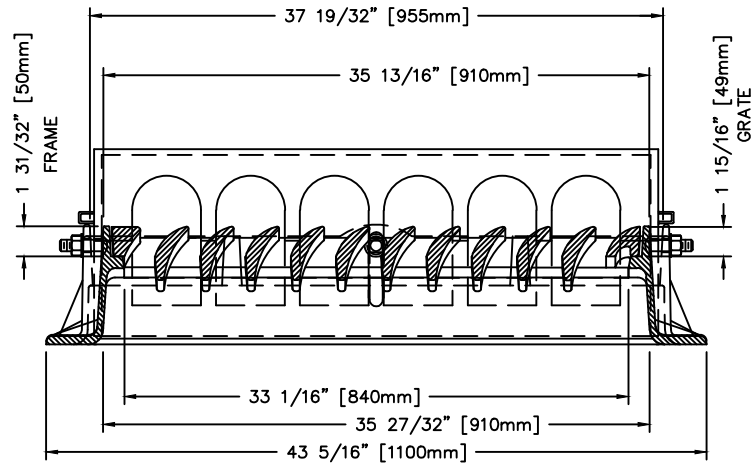


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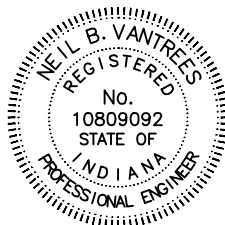
FIGURE ST-07



NEENAH	R-3287-10V
EAST JORDAN	7505 M1 & T2

- * OR APPROVED BY WESTFIELD PUBLIC WORKS DEPARTMENT
- ** STORM SEWER CASTINGS MANHOLE COVERS, BEEHIVE INLETS, CURB INLETS OR OTHER APPROVED CASTING SHALL HAVE THE FOLLOWING PHRASES CAST IN RECESSED LETTERS TWO (2) INCHES IN HEIGHT:
- "STORM SEWER"
 - "DRAINS TO RIVER" OR "DRAINS TO WATERWAY"
 - "DUMP NO WASTE"
 - OTHER PHRASES SHALL REQUIRE APPROVAL OF THE WESTFIELD PUBLIC WORKS DEPARTMENT.

CHAIR BACK CURB INLET CASTING

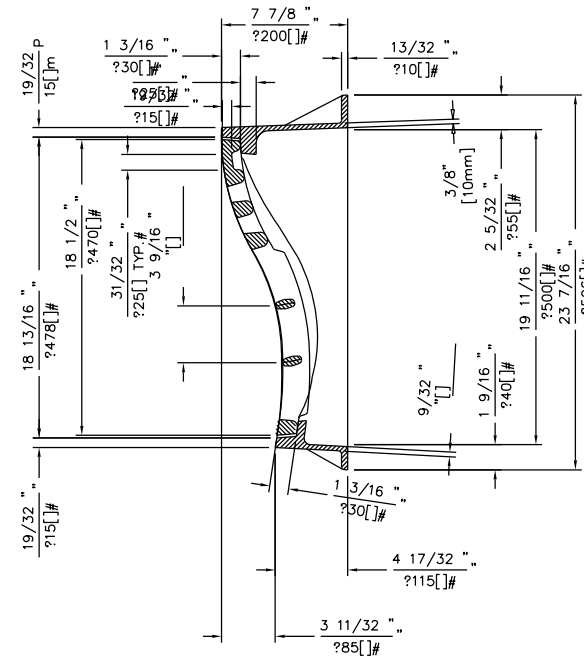


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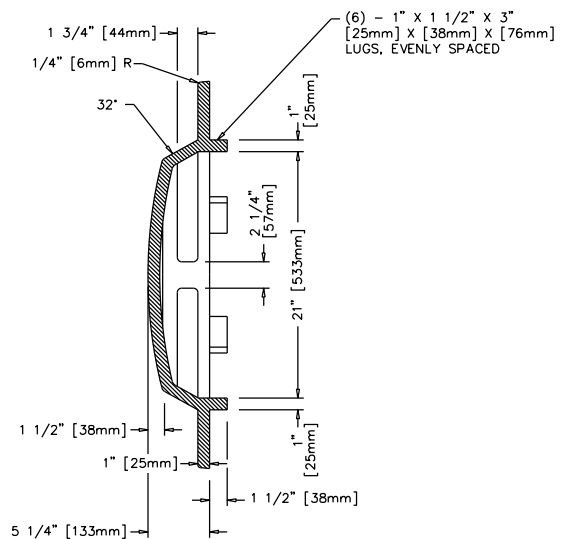
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FIGURE ST-8



NEENAH	3501-TL OR TR
EAST JORDAN	7495-M2 OR M1
USF	5254 & 6233 (L OR R)

FIGURE ST-09

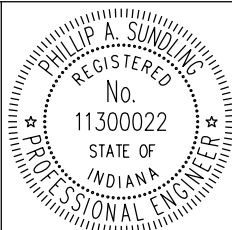


NEENAH	R-4342
EAST JORDAN	6489
USF	5695

- NOTES:

FOR NEENAH R-4342:
FREE OPEN AREA = 278 SQ. IN.
WEIGHT = 196#

BEEHIVE INLET CASTING



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FIGURE ST-10


STR. NO.	TC/RIM ELEV.	INV. IN	INV. OUT	DEPTH	STR. SIZE	STR. TYPE	CASTING TYPE	PIPE SIZE	DIRECTION OF PIPE IN/OUT	STORM BMP YES/NO

DEPTH = T/C - (INV + DIA + THICKNESS)


NOTE: TABLE TO BE LOCATED ON DEVELOPMENT PLAN.

STRUCTURE DATA TABLE





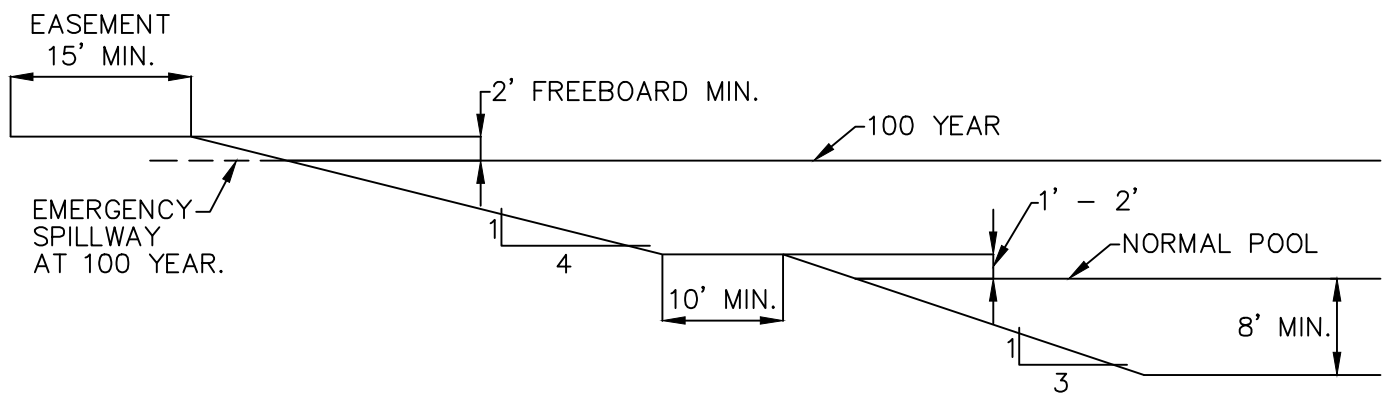
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FIGURE ST-16



USE OUTLET OPTION 1 (SEE FIGURE ST-26)

LAKE CROSS SECTIONS: OPTION 1

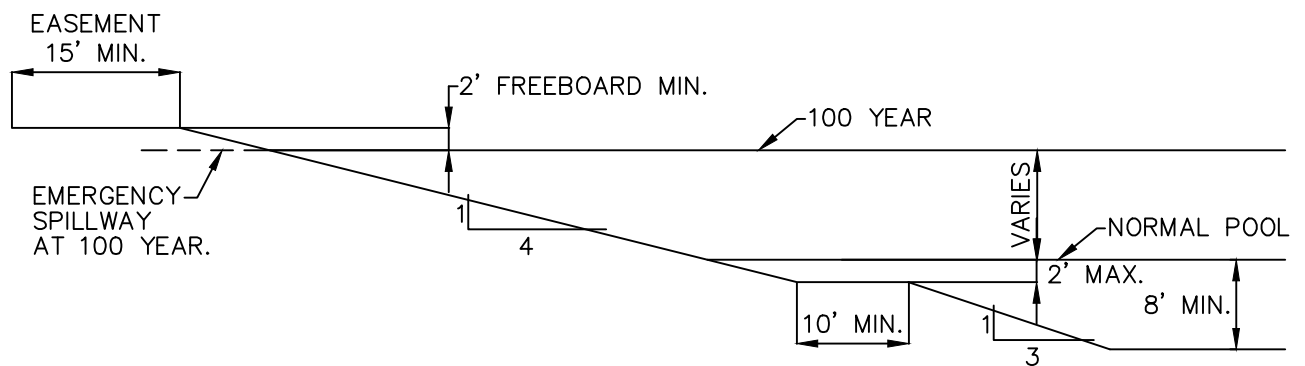


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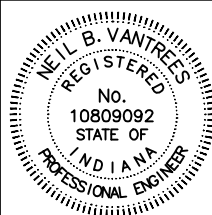
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FIGURE ST-23



USE OUTLET OPTION 2 (SEE FIGURE ST-27)

LAKE CROSS SECTIONS: OPTION 2

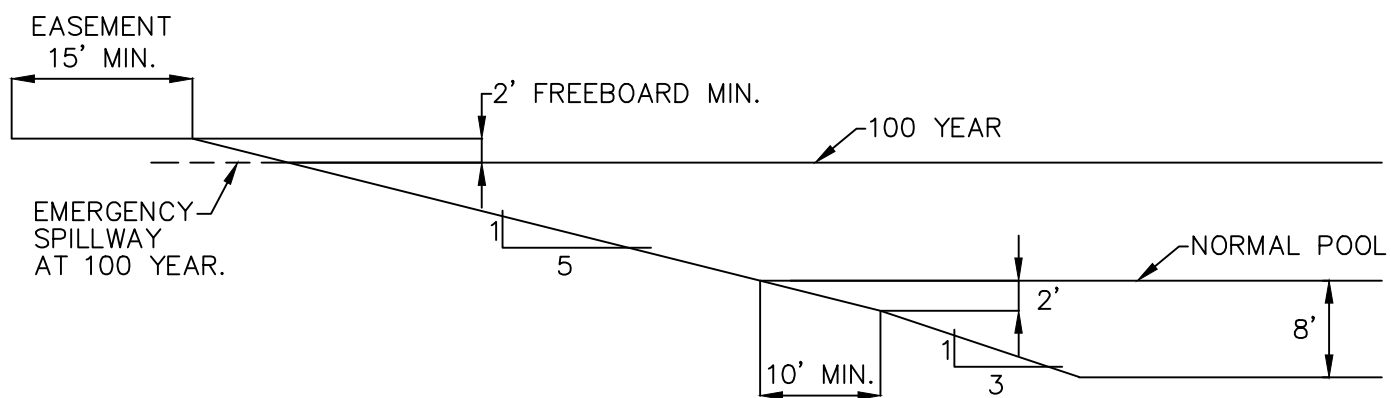


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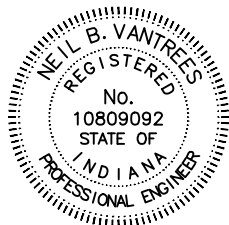
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FIGURE ST-24



USE OUTLET OPTION 3 (SEE FIGURE ST-28)

LAKE CROSS SECTIONS: OPTION 3



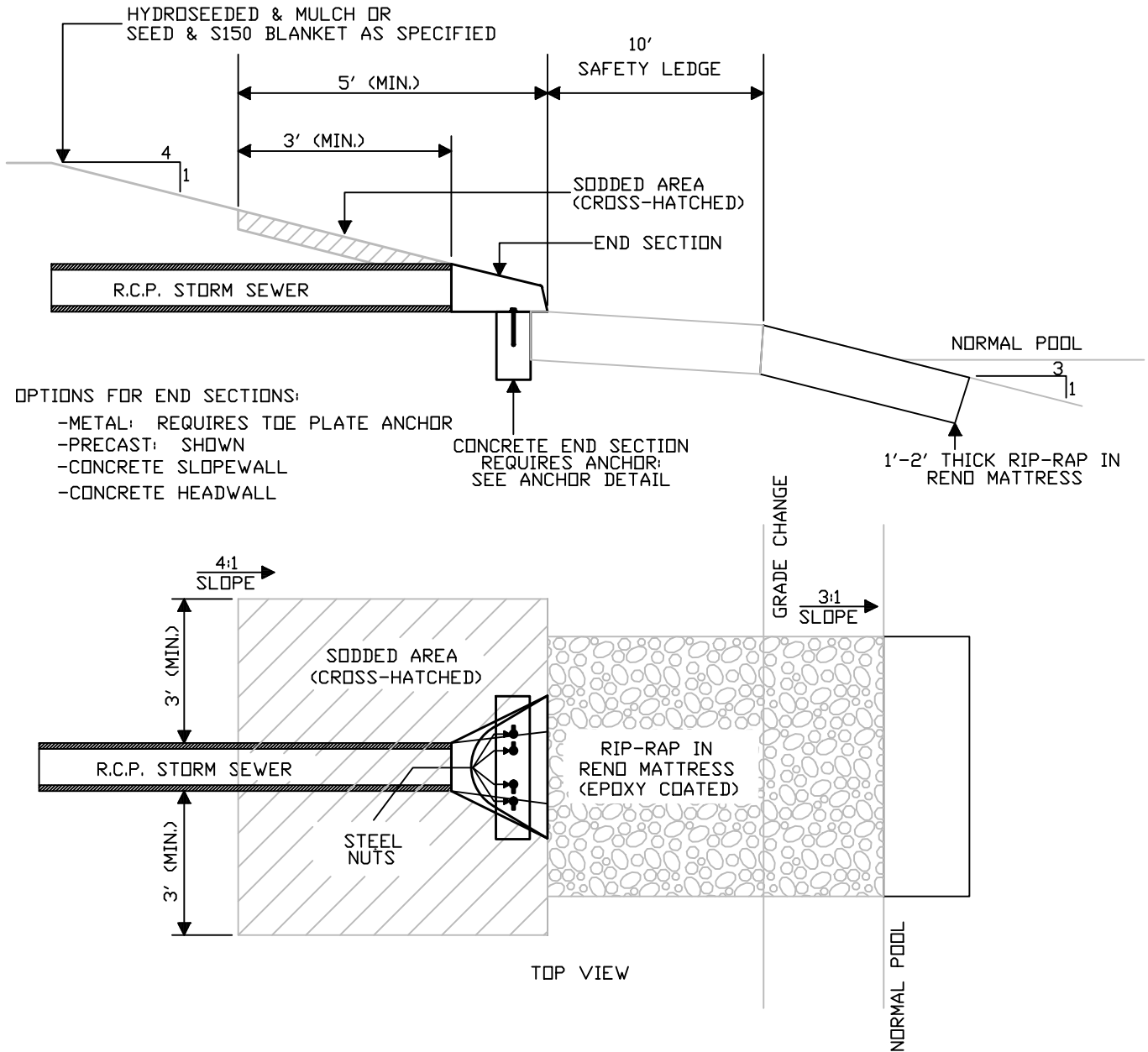
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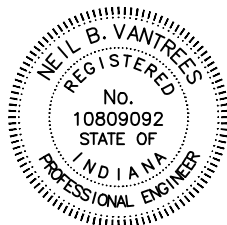
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FIGURE ST-25

UNDERWATER DISCHARGE NOT ALLOWED



LAKE OUTLET DETAIL FOR LAKE CROSS-SECTION OPTION 1

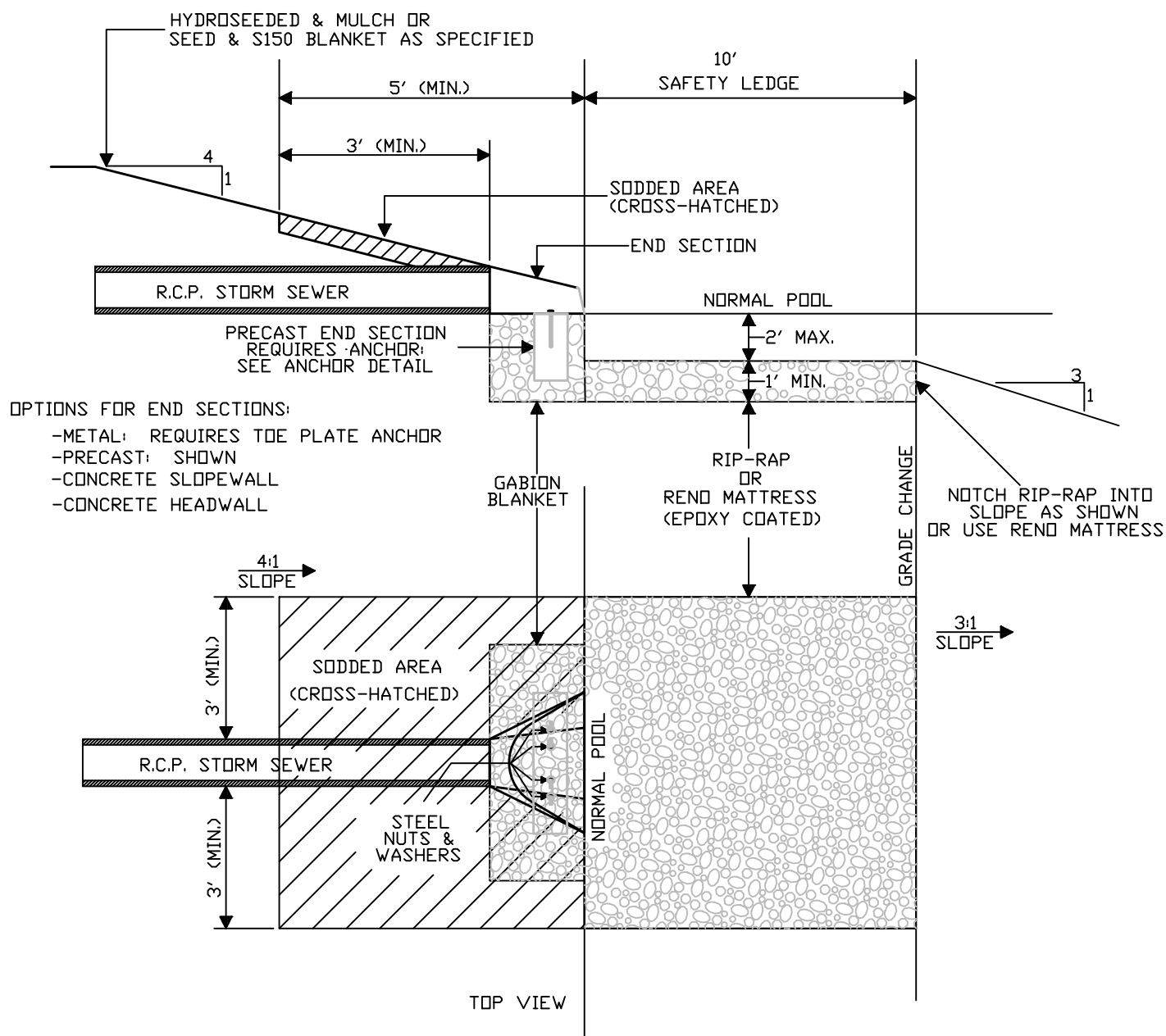


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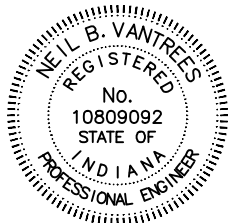
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FIGURE ST-26



LAKE OUTLET DETAIL FOR LAKE CROSS-SECTION OPTION 2



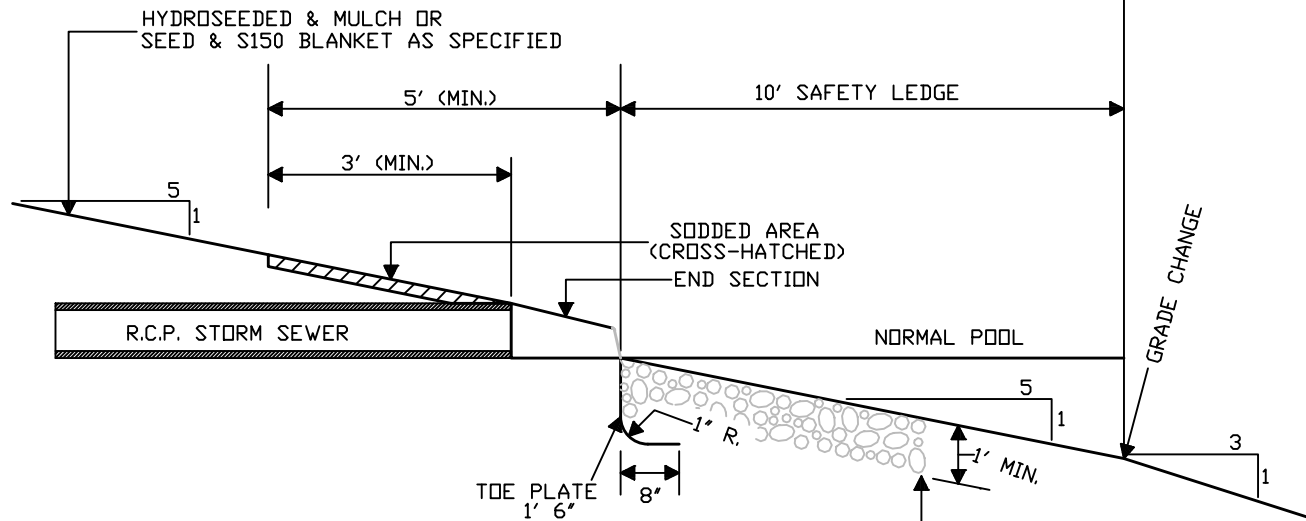
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FIGURE ST-27

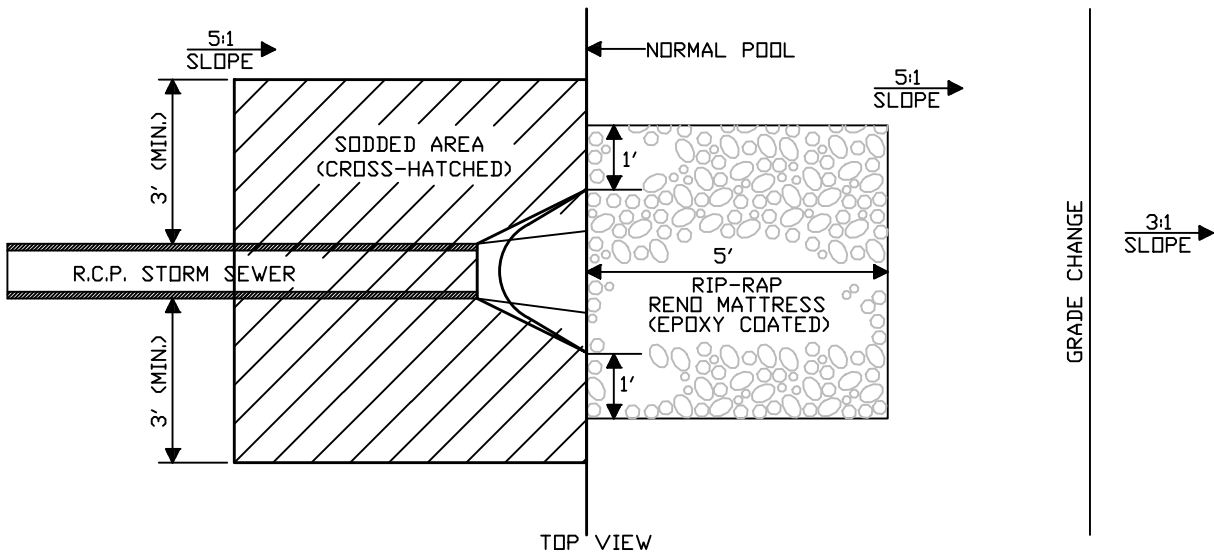
UNDERWATER DISCHARGE NOT ALLOWED



OPTIONS FOR END SECTIONS:

- METAL: SHOWN/REQUIRES TOE PLATE ANCHOR
- PRECAST: REQUIRES ANCHOR W/ TOE WALL
- CONCRETE SLOPEWALL
- CONCRETE HEADWALL

NOTCH RIP-RAP INTO SLOPE AS SHOWN
USE REND MATTRESS



LAKE OUTLET DETAIL FOR LAKE CROSS-SECTION OPTION 3



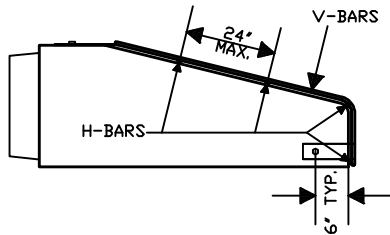
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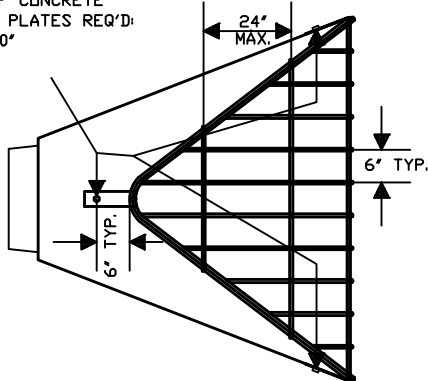
FIGURE ST-28

SIDE PROFILE



TOP VIEW

BOLT TO APRON 6\"/>



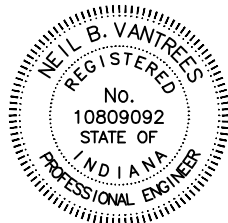
Apron Size Inches	V-bar Size Inches	No. of H-bars Req'd	H-bar Size Inches	Bolt Dia. Inches	"A" Dim. Inches
18	1/2	3	5/8	1/2	5
24	5/8	4	3/4	1/2	7
30	5/8	4	3/4	1/2	7 1/2
36	3/4	4	1	1/2	10 1/2
42	3/4	4	1	3/4	11
48	3/4	4	1 1/2 pipe	3/4	12
54	3/4	4	1 1/2 pipe	3/4	12
60	3/4	5	1 1/2 pipe	3/4	14
72	3/4	5	1 1/2 pipe	3/4	14
84	3/4	6	1 1/2 pipe	3/4	15

Round pipe aprons	12	1/2	3	5/8	1/2	4
	15	1/2	3	5/8	1/2	4 1/2
	18	1/2	4	5/8	1/2	4 1/2
	21	1/2	4	5/8	1/2	5
	24	5/8	4	3/4	1/2	5
	27	5/8	4	3/4	1/2	5 1/2
	30	5/8	4	3/4	1/2	5 1/2
	36	3/4	4	1	3/4	8
	42	3/4	4	1	3/4	8
	48	3/4	5	1	3/4	8
	54	3/4	5	1 1/2 pipe	3/4	8
	60	3/4	5	1 1/2 pipe	3/4	8
	66	3/4	6	1 1/2 pipe	3/4	8
	72	3/4	6	1 1/2 pipe	3/4	9
	84	3/4	7	1 1/2 pipe	3/4	10
90	3/4	7	1 1/2 pipe	3/4	14	

NOTES:

1. BARS & PLATES ARE HOT-ROLLED STEEL.
2. BARS, PLATES, & PIPE ARE FINISHED WITH 2 COATS OF ALUMINUM PAINT.
3. BOLTS ARE GALVANIZED
4. NO REBAR THROUGH PIPES WILL BE ALLOWED
5. DEBRIS GUARD SHALL BE REMOVABLE

DEBRIS GUARD

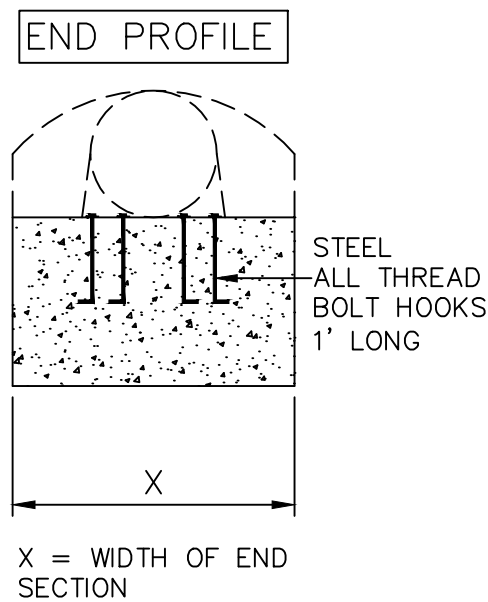
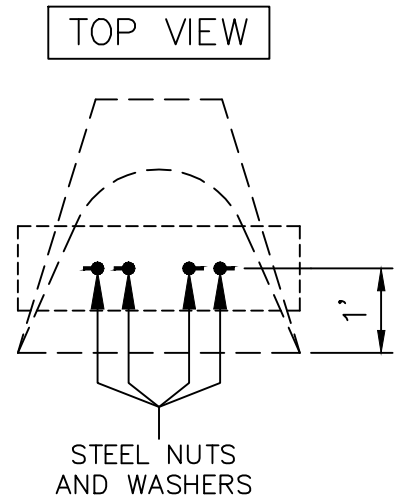
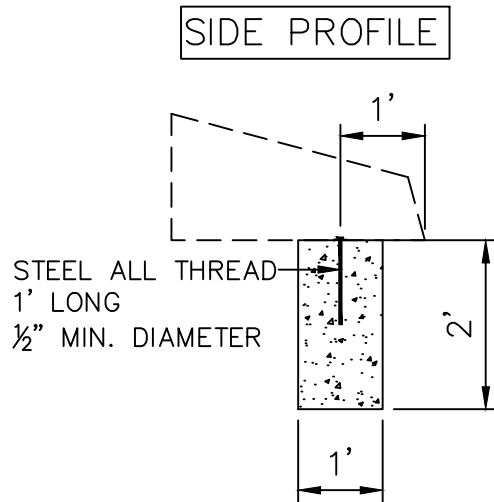


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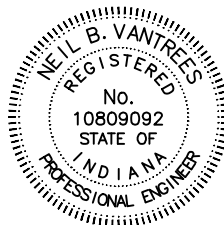
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FIGURE ST-29



ALLTHREAD SPACING TO BE TWO PER FOOT
EX: 12" END SECTION = 2 ALLTHREAD
24" END SECTION = 4 ALLTHREAD

ANCHOR FOR CONCRETE END SECTIONS

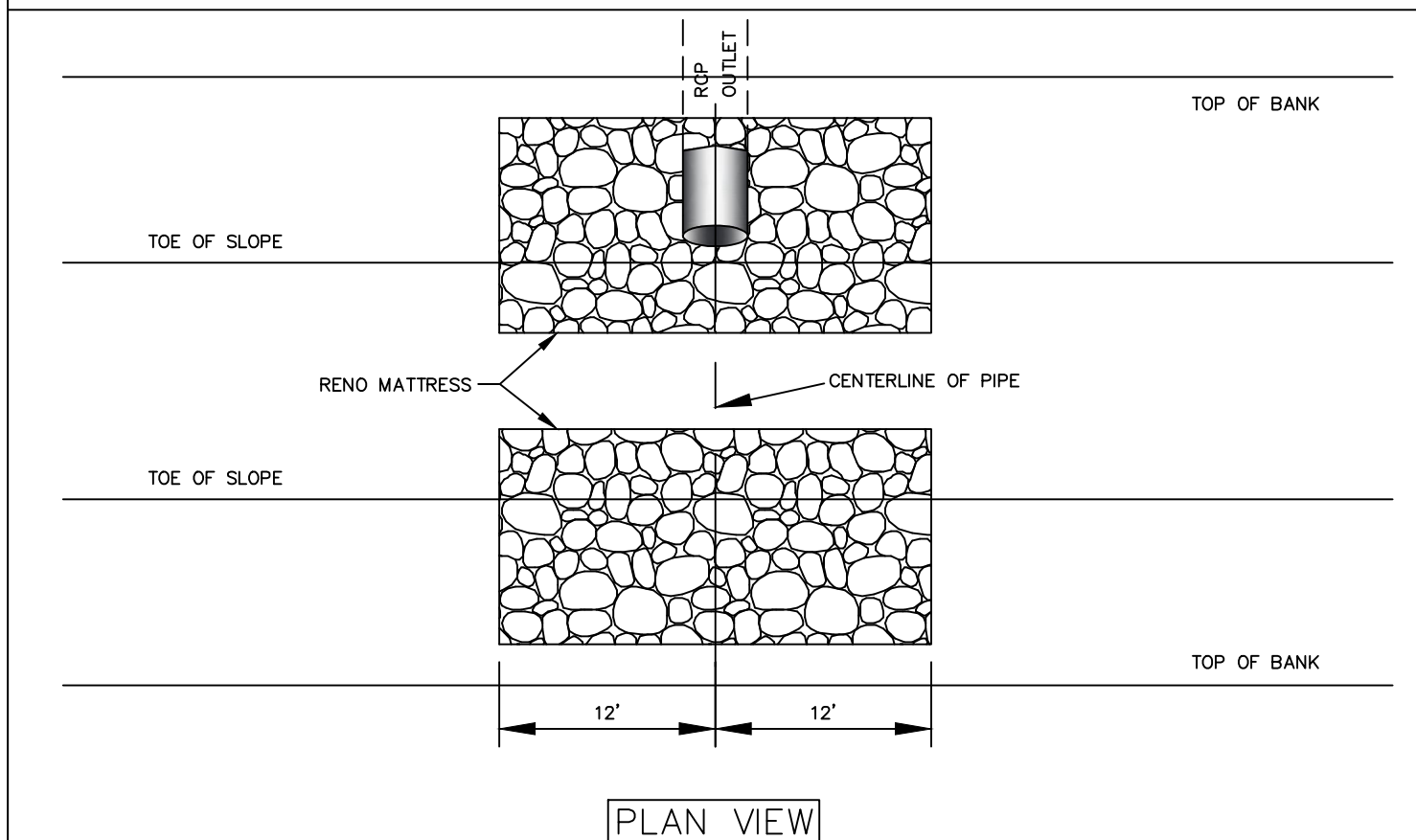
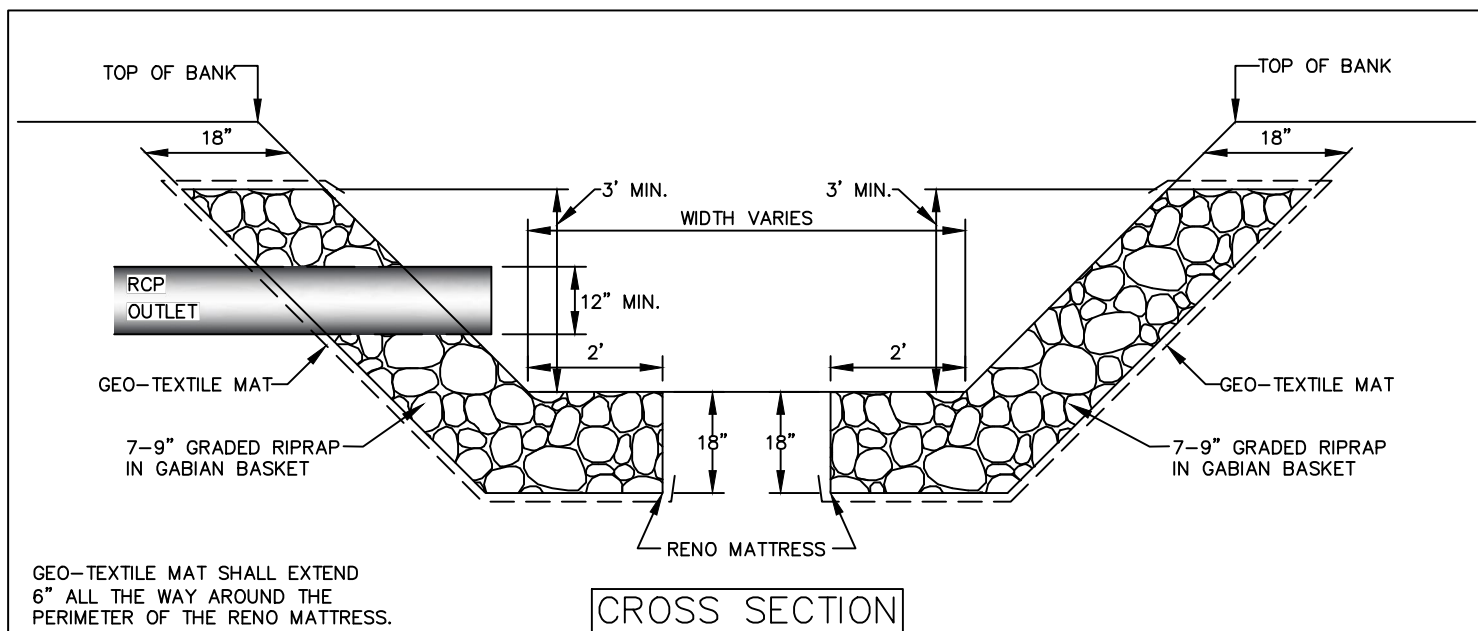


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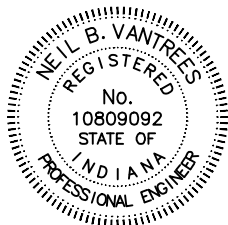
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FIGURE ST-30



BANK ARMORMENT AT OUTLET PIPE IN OPEN CHANNELS

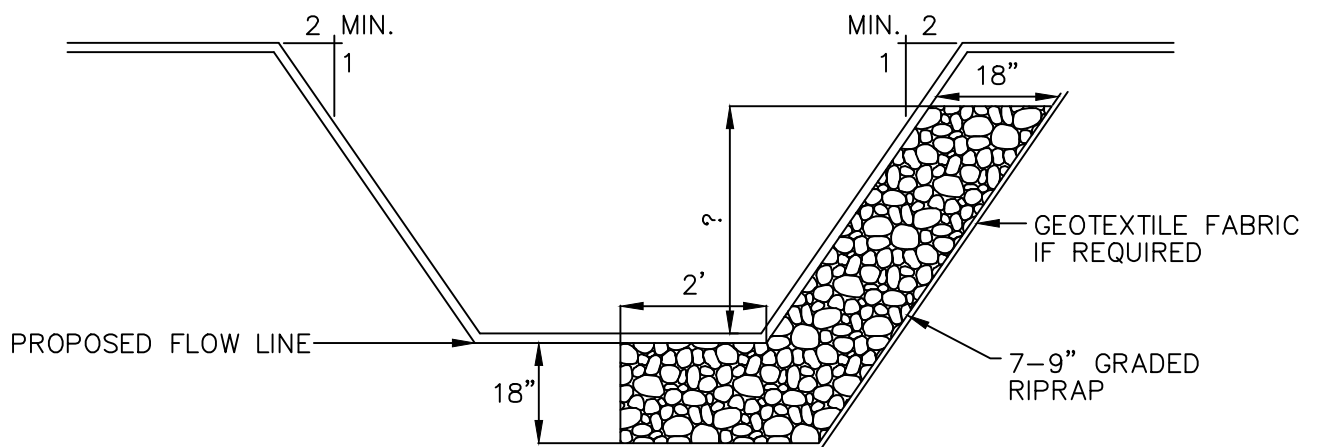
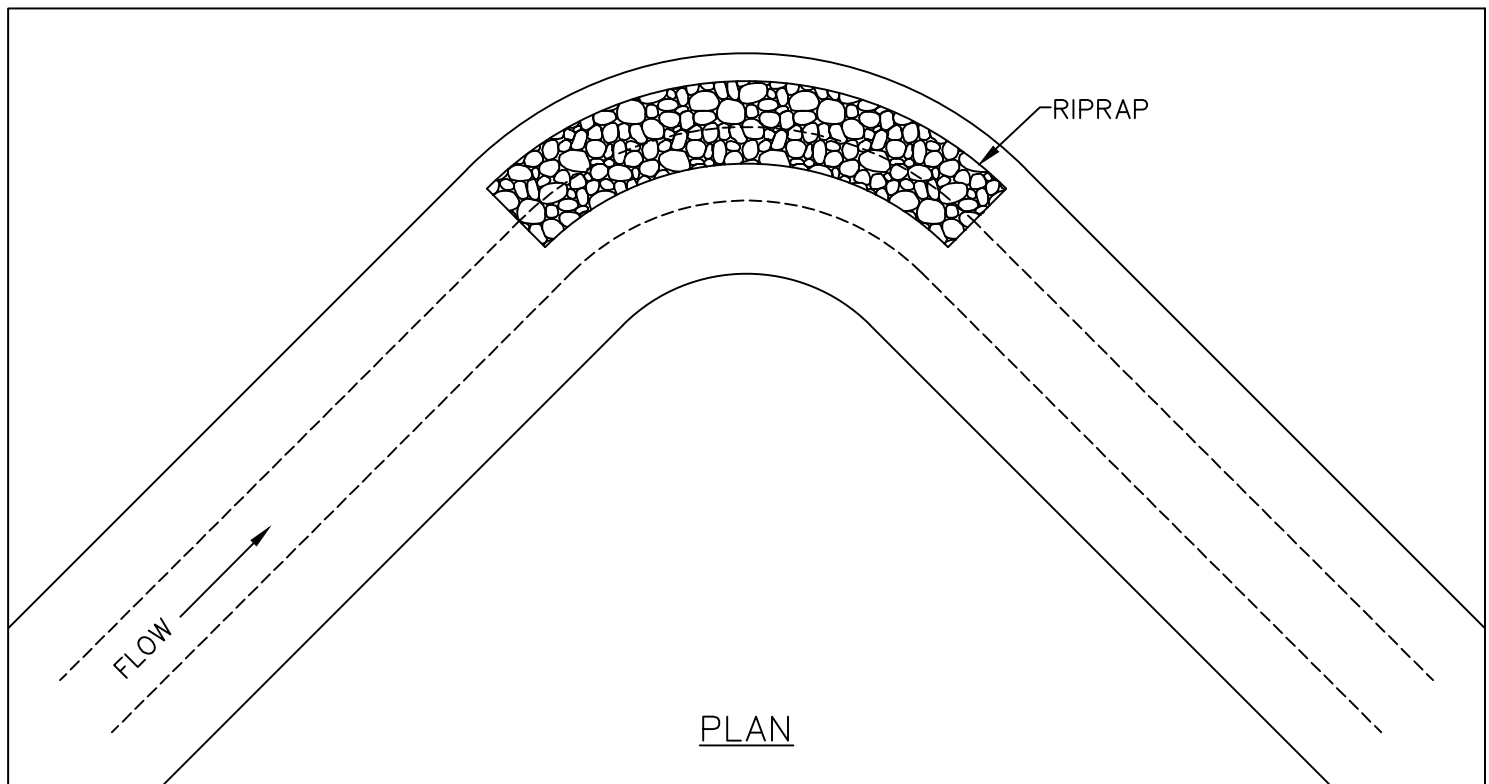


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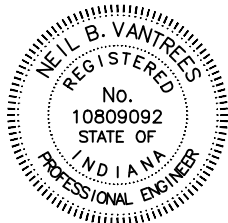
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FIGURE ST-31



GEOTEXTILE FABRIC MAY BE REQUIRED, DEPENDING ON SOIL CONDITIONS.

CORNER PROTECTION



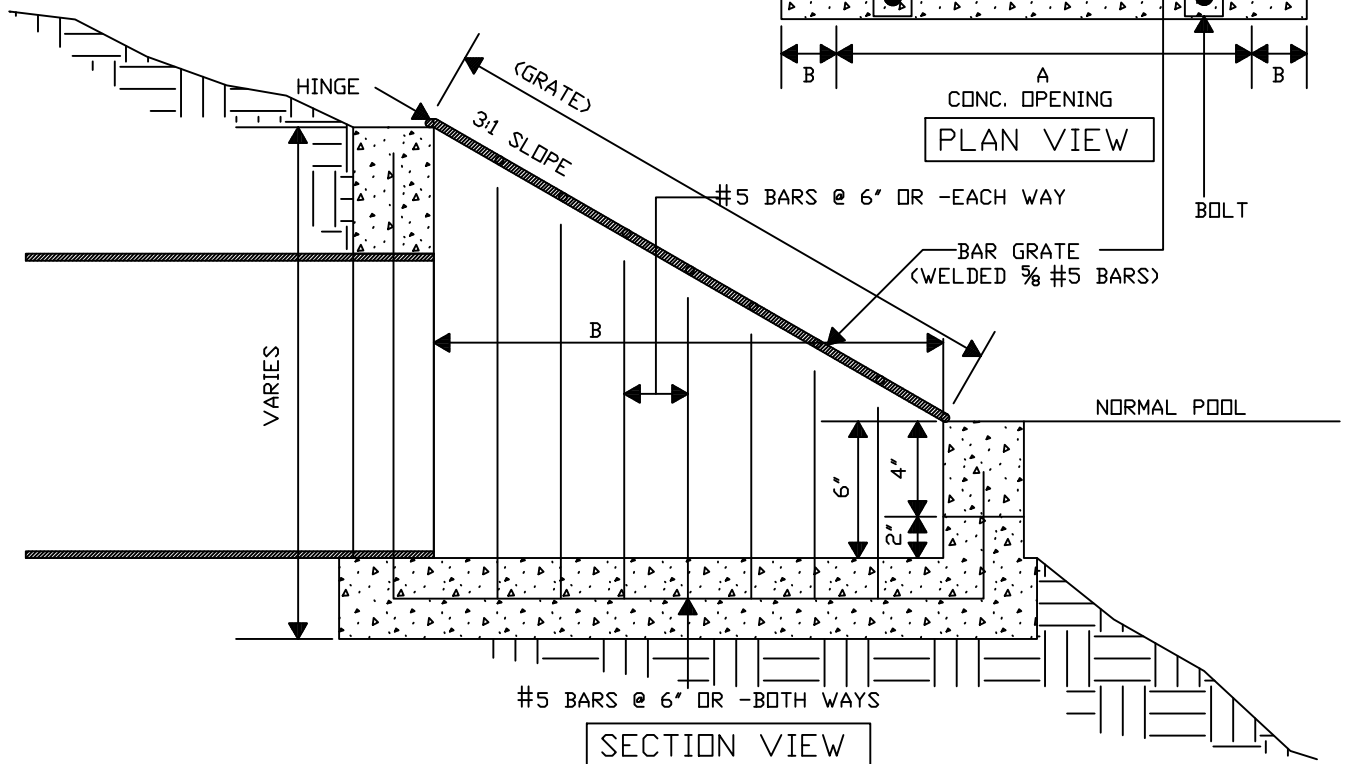
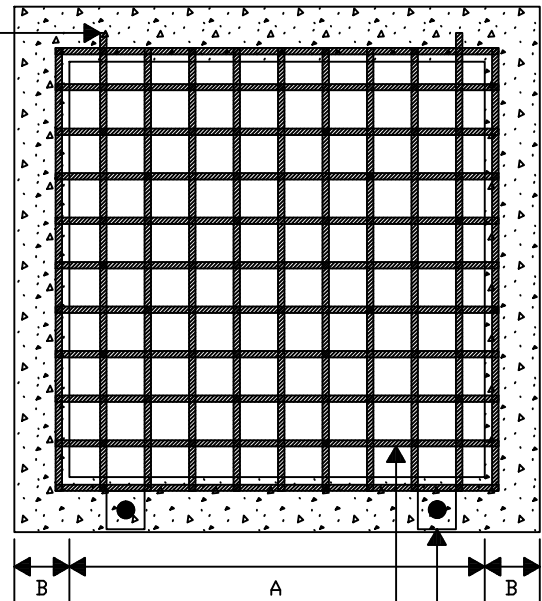
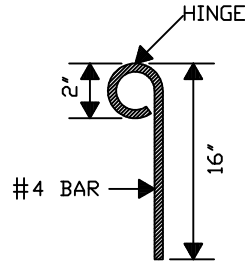
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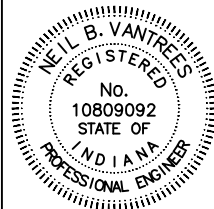
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FIGURE ST-32

PIPE SIZE	A	B
12"	3'	4'
15"	3'	4'
18"	3'	4'
36"	4'	6'



POND OUTFALL STRUCTURE



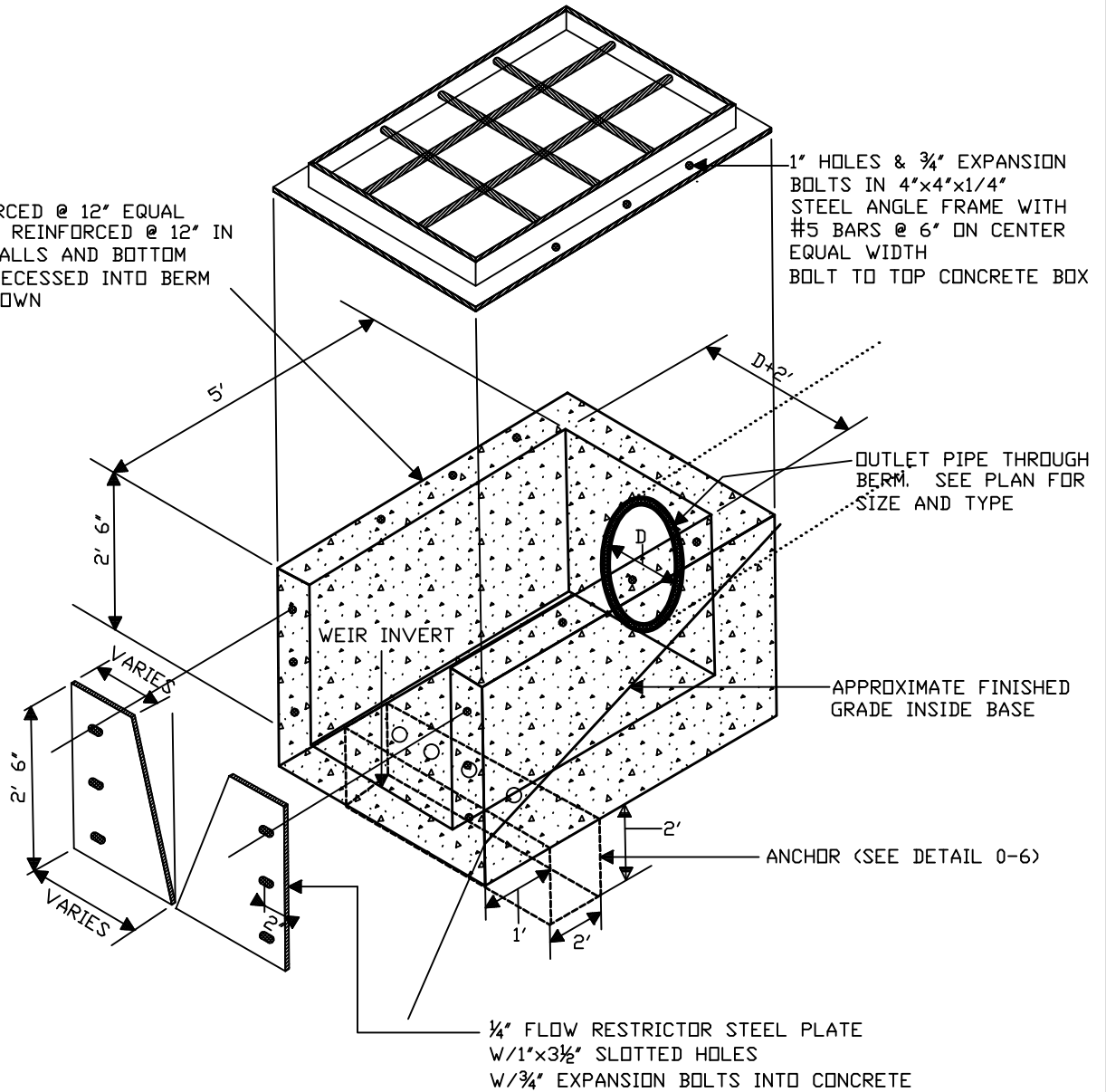
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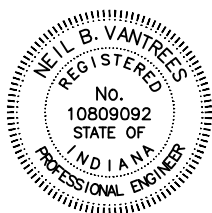
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FIGURE ST-33

#5 REINFORCED @ 12" EQUAL
WIDTH IN 5 REINFORCED @ 12" IN
6" THICK WALLS AND BOTTOM
WEIR BOX RECESSED INTO BERM
SIDE AS SHOWN



ISOMETRIC @ WEIR OUTLET



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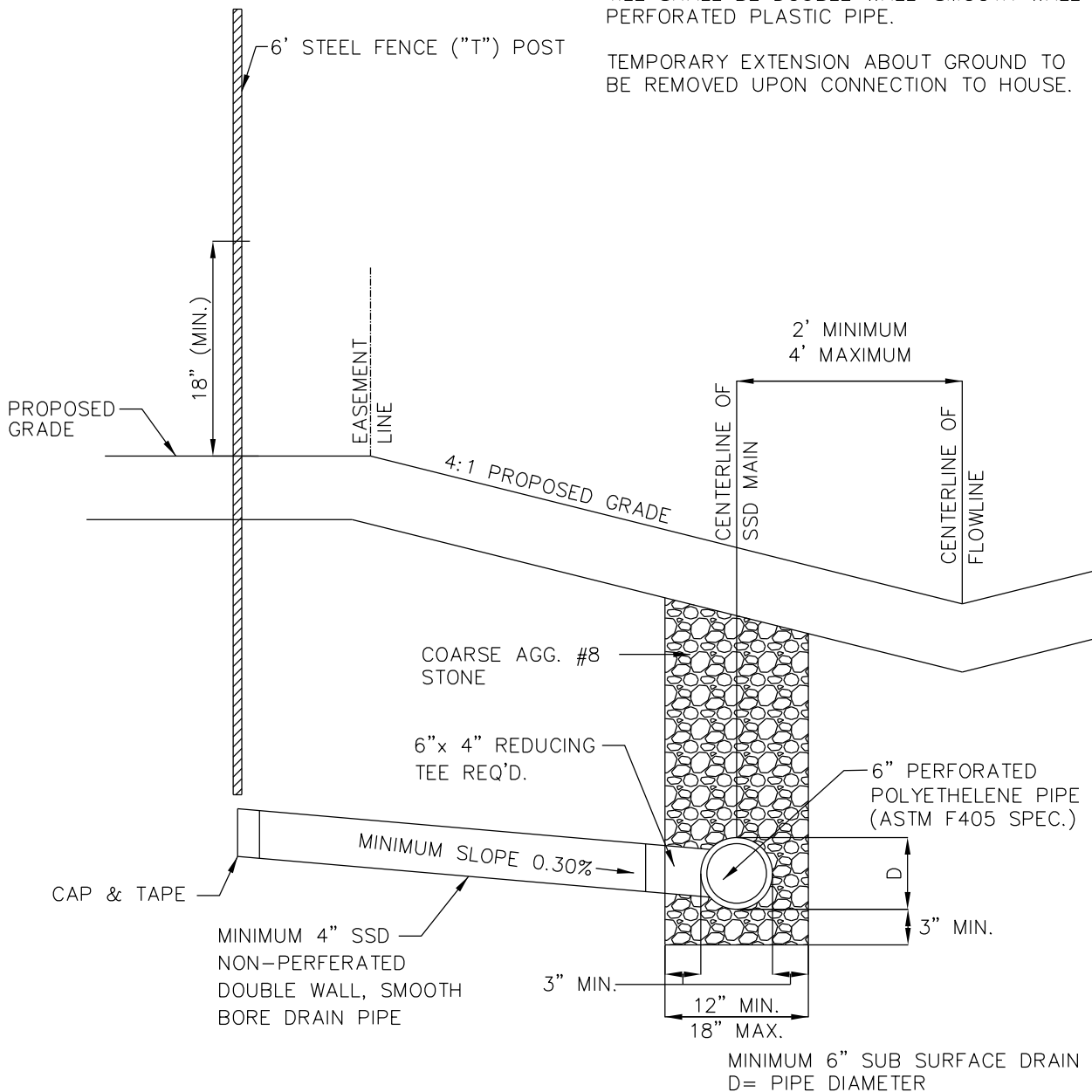
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FIGURE ST-34

NOTES:

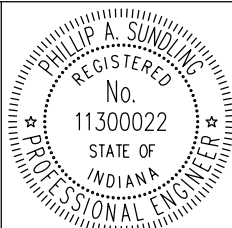
TILE SHALL BE DOUBLE WALL-SMOOTH WALL PERFORATED PLASTIC PIPE.

TEMPORARY EXTENSION ABOUT GROUND TO BE REMOVED UPON CONNECTION TO HOUSE.



TYPICAL SUBSURFACE DRAIN (SSD) LATERAL TO INDIVIDUAL LOTS IN REAR YARD SWALE

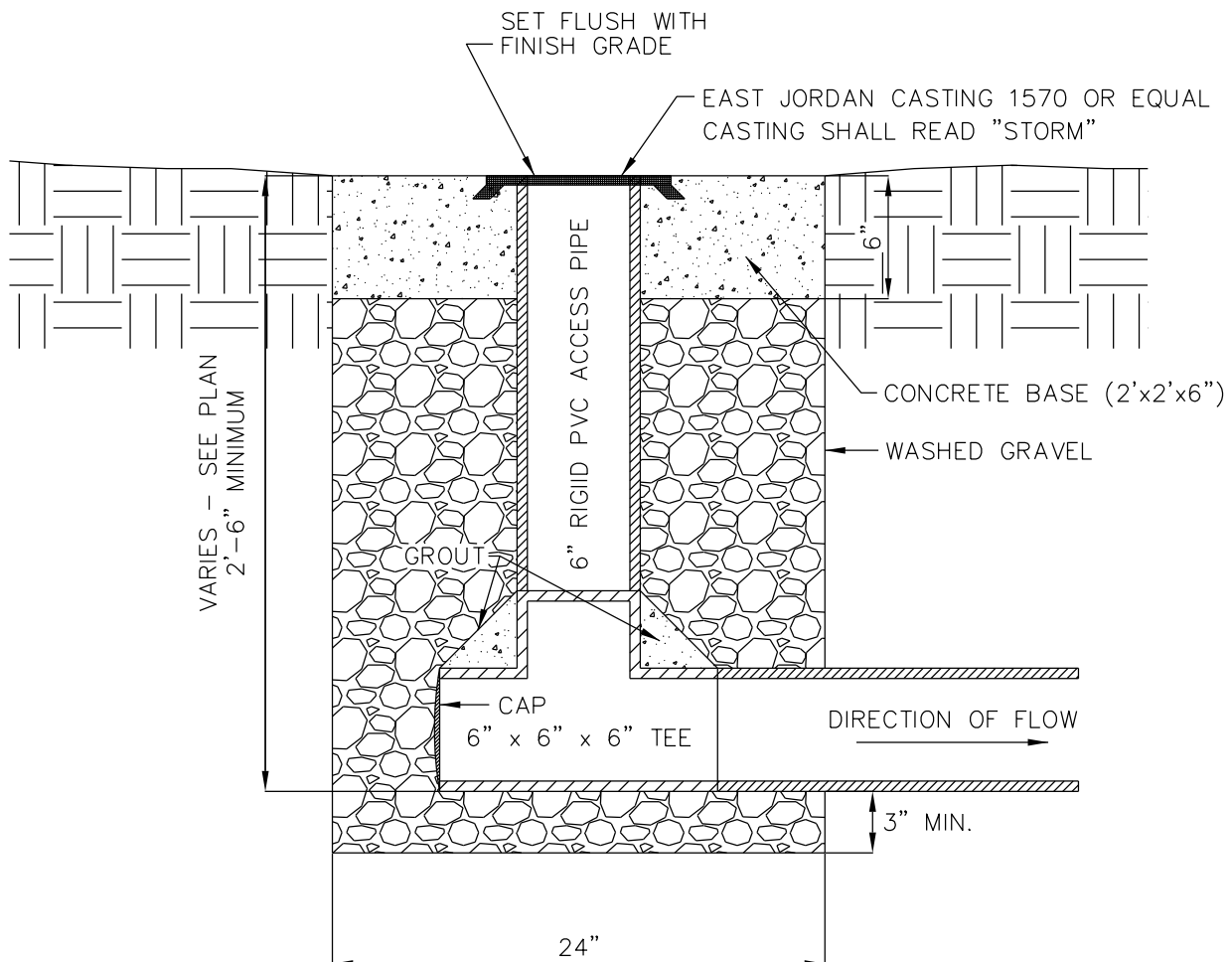
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FIGURE ST-36

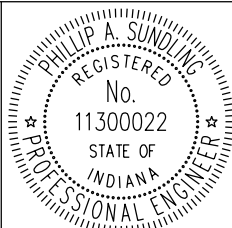


NOTE: MINIMUM 6" SUB SURFACE DRAIN
D= PIPE DIAMETER

NOTE: TILE SHALL BE DOUBLE WALL SMOOTH
WALL PERFORATED HDPE PIPE.

SUBSURFACE DRAIN (SSD) RISER DETAIL

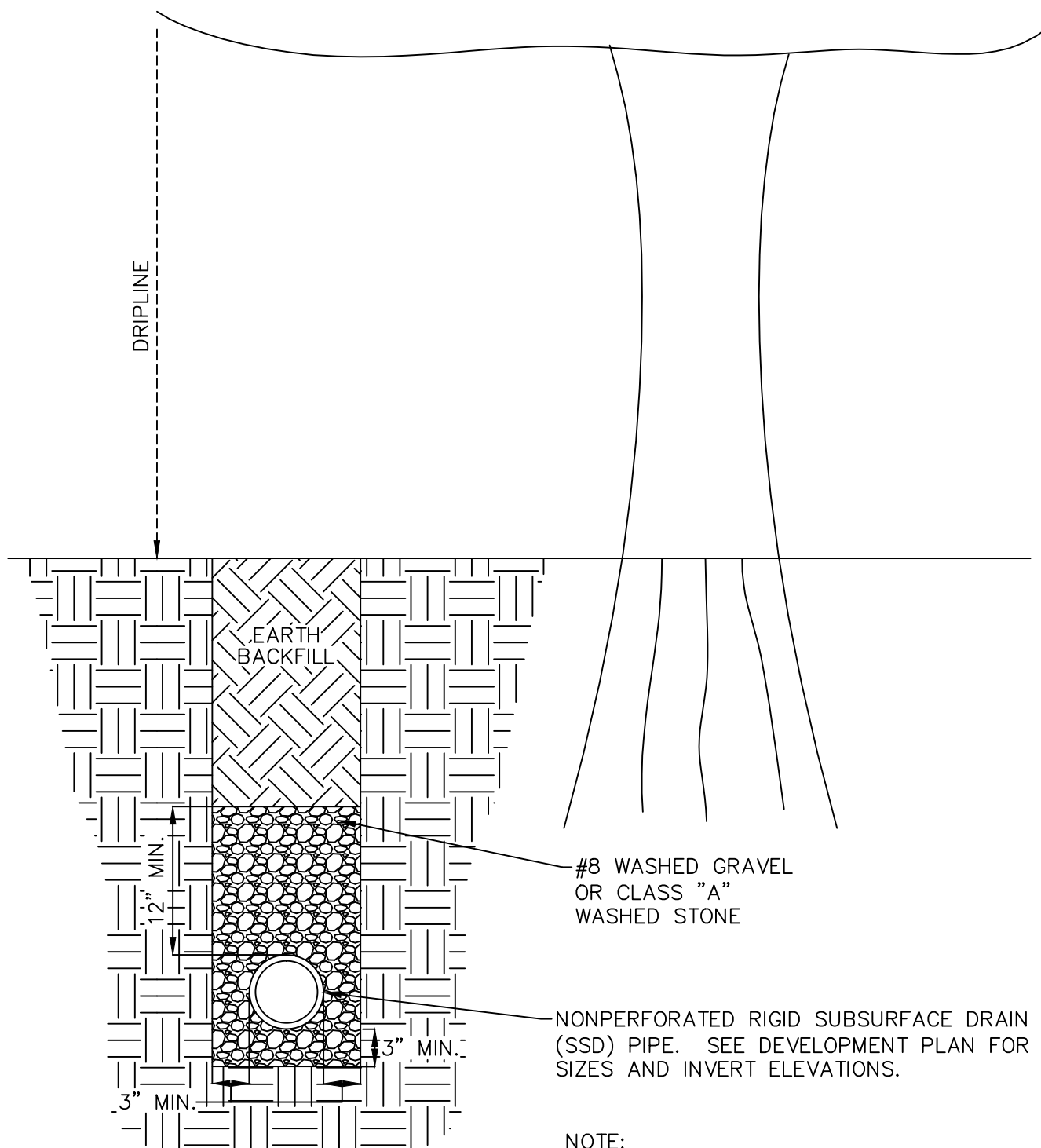
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FIGURE ST-37



SUBSURFACE DRAIN (SSD) DETAIL WHEN WITHIN DRIPLINE OF EXISTING TREES

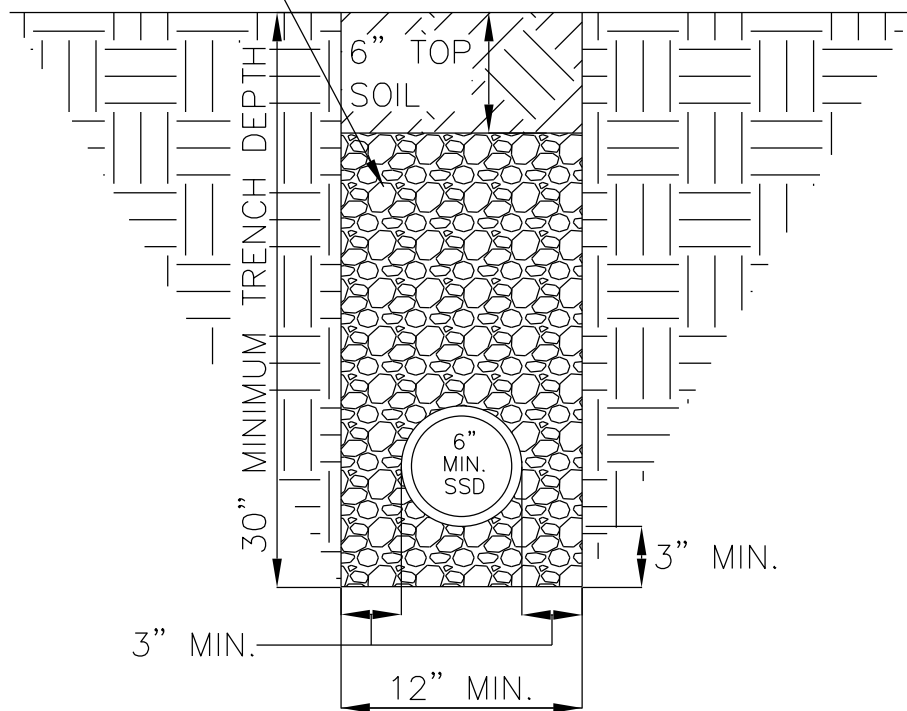


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FIGURE ST-39

COARSE AGG. #8
STONE



NOTE:
TILE SHALL BE DOUBLE WALL, SMOOTH
WALL PERFORATED HDPE PIPE.

SUBSURFACE DRAIN (SSD) – NO SWALE

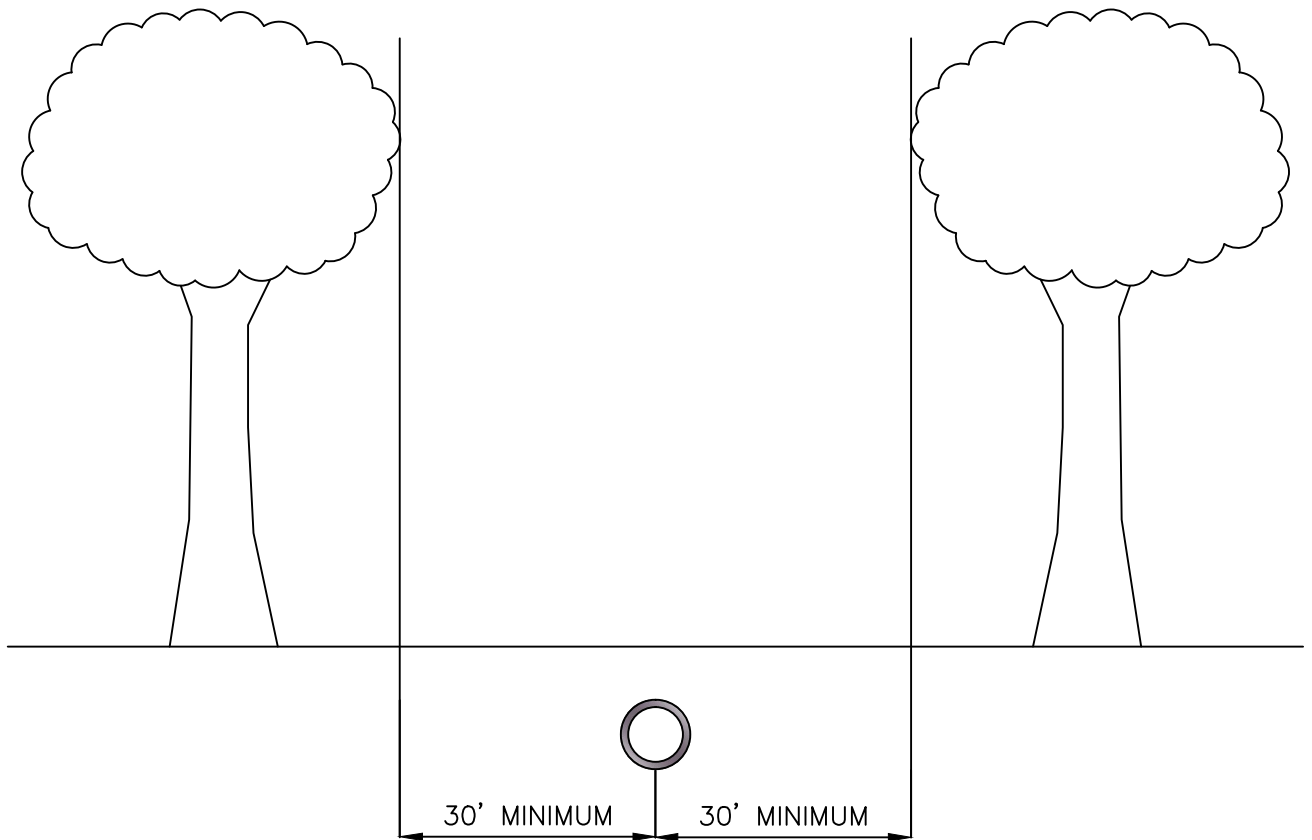
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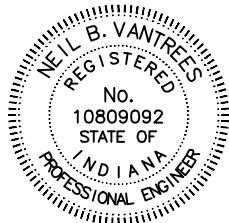
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FIGURE ST-40



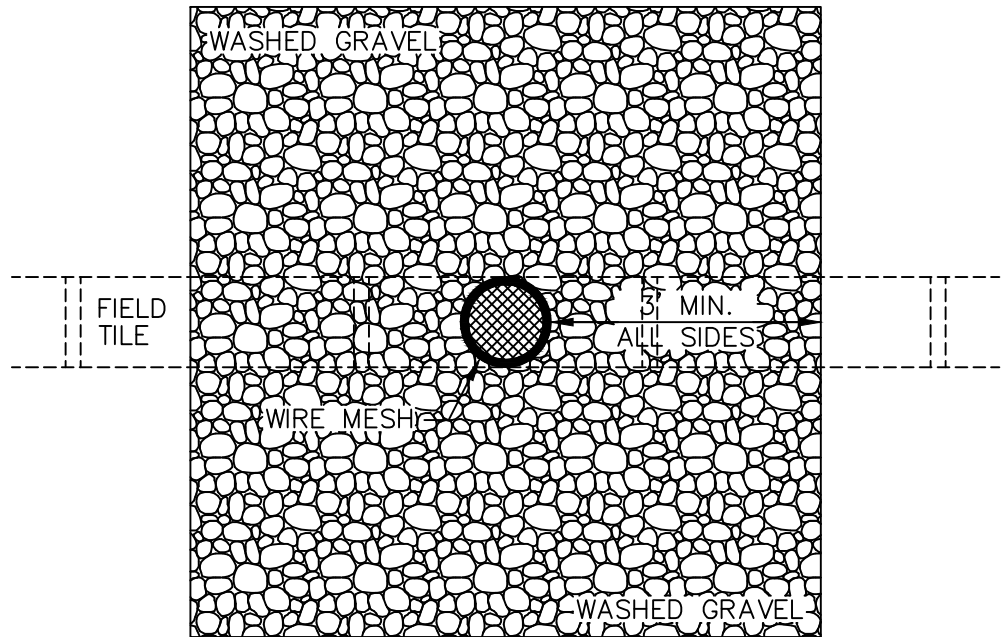
TILE CLEARING THROUGH WOODS



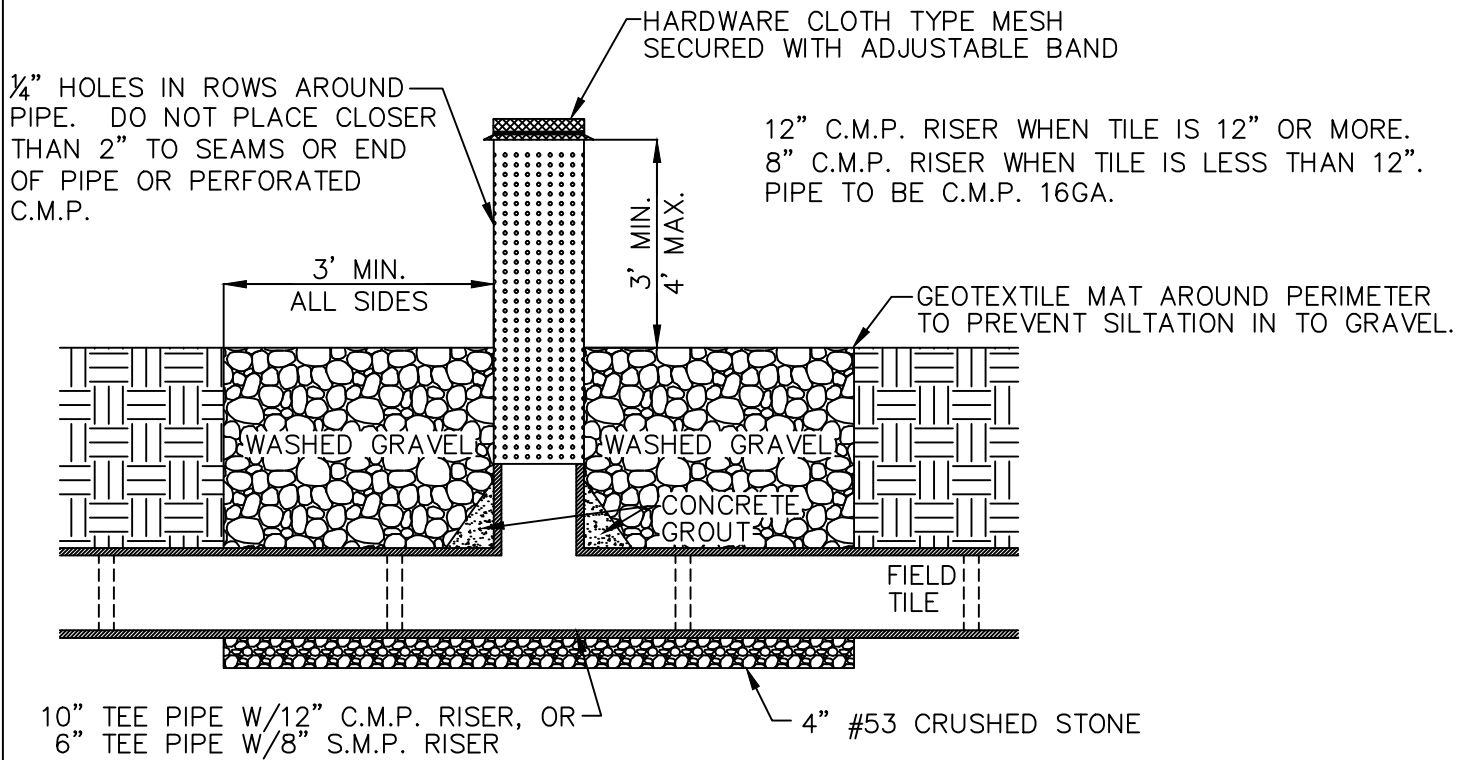
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FIGURE ST-41



TOP VIEW



CROSS SECTION

SLOTTED RISER INLET DETAILS

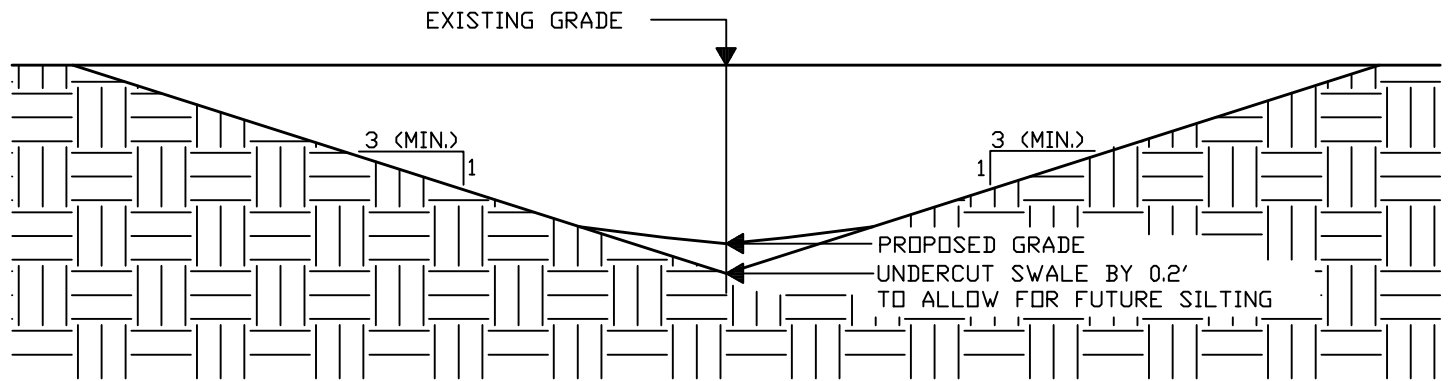


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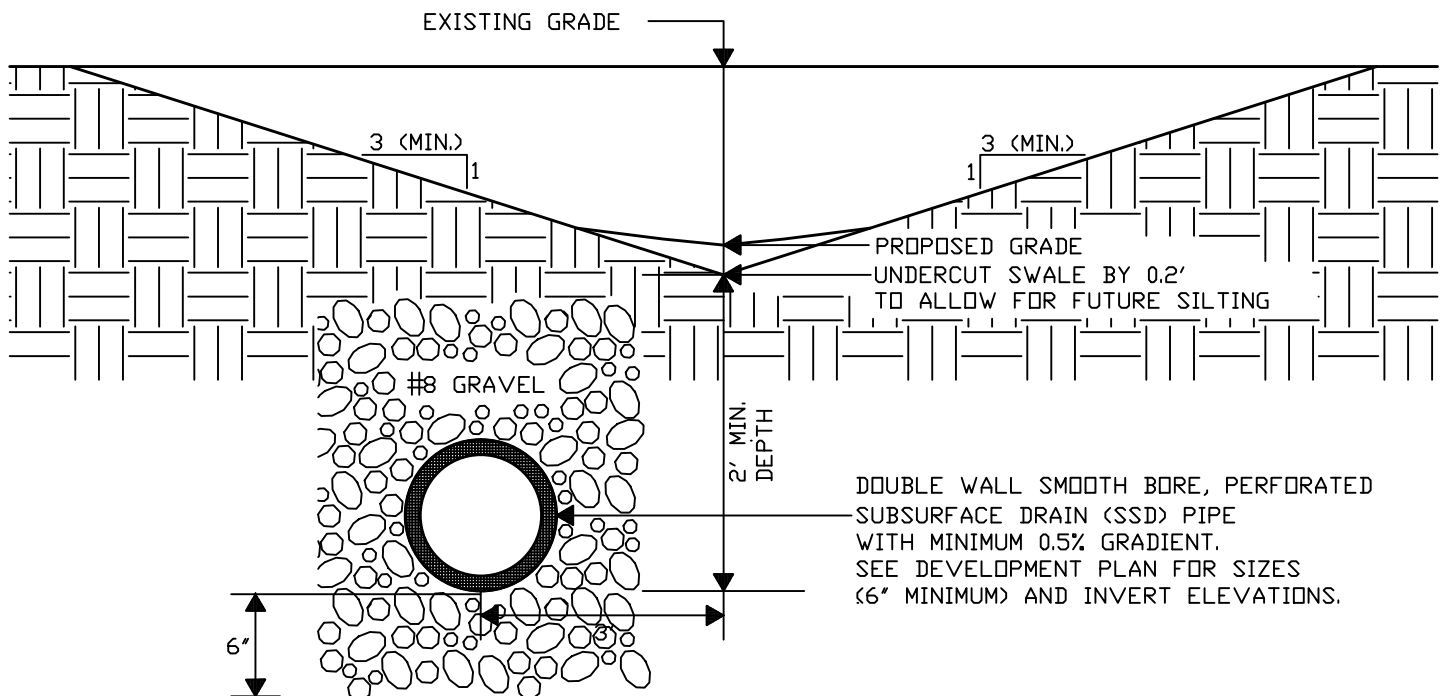
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FIGURE ST-42



UNDERDRAINS REQUIRED IN SWALES WITH SLOPE BETWEEN 1% & 2% GRADIENT



MINIMUM CHANNEL SLOPE 1% GRADIENT

TYPICAL SWALE DETAIL

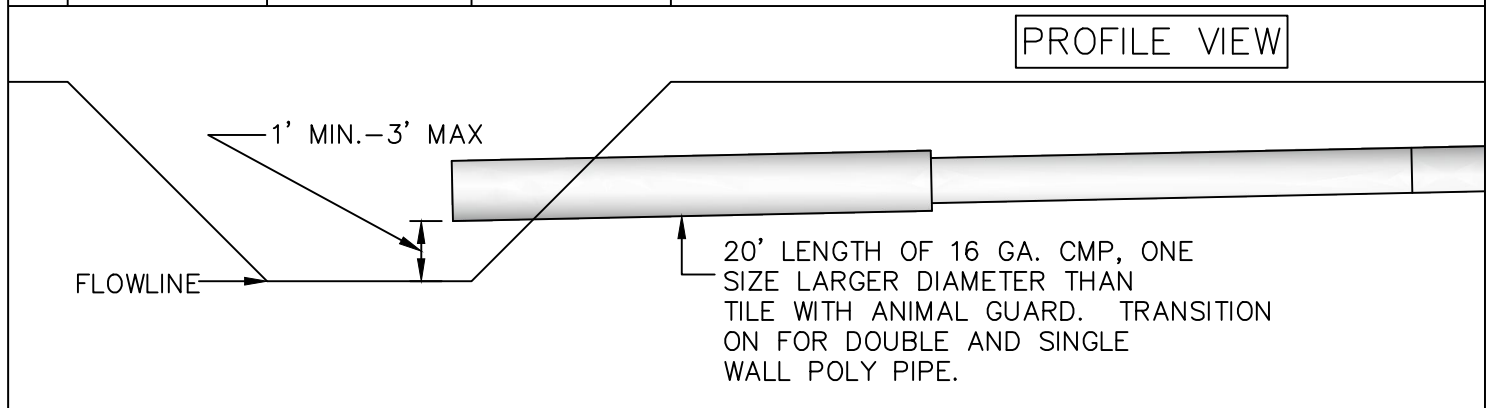
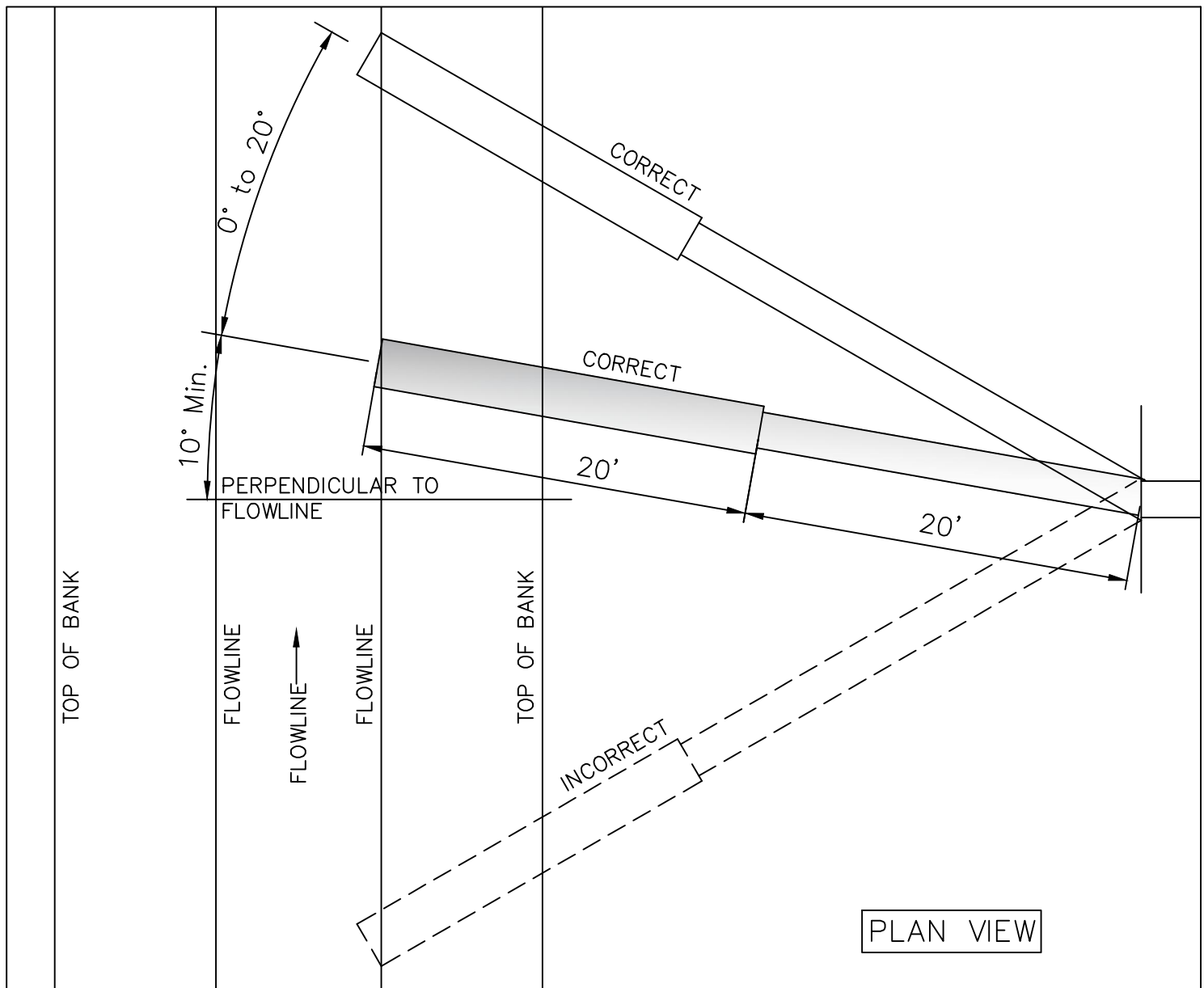


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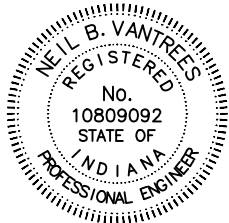
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FIGURE ST-43



DRAIN OUTLET DETAIL #1



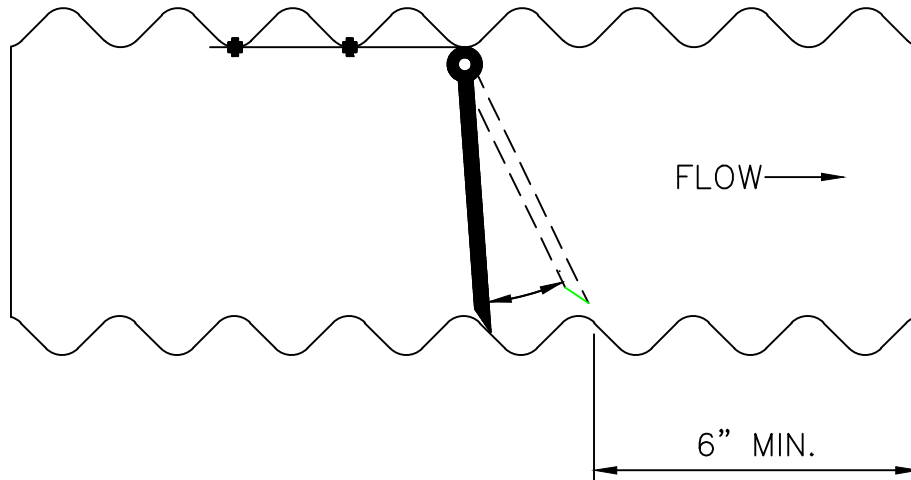
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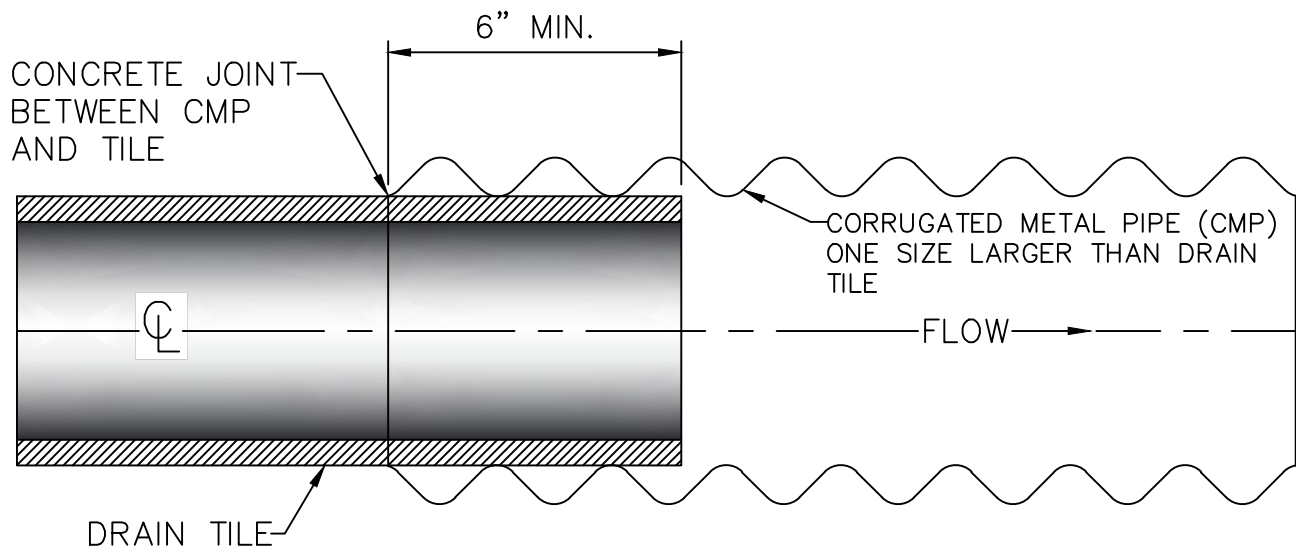
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FIGURE ST-44

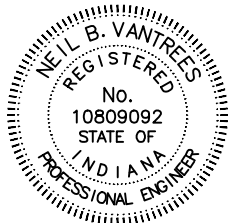
FLAP TYPE ANIMAL GUARD DETAIL



SECTION ON ϕ SHOWING DETAIL OF JOINT FOR DRAIN TILE AND CMP PIPE



DRAIN OUTLET DETAIL #2



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FIGURE ST-45